THE

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ELECTRICAL REVIEW.

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THE

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THE NEW YEAR.

As we write these lines we stand upon the threshold of a new year, and in keeping with the disposition of humankind in general, have been indulging in reflections respecting past days, and looking out to greet those that are coming, in a spirit of anxious expectancy. The electrical industry is, of course, our great concern in these columns, and in looking backward it is not easy to select any one development, discovery, or important piece of electrical or scientific work, and describe that particular event as the outstanding electrical feature of the year. It has been a year of radium, of single-phase motors for traction, and these are, perhaps, its chief sensations; it has also been a year of new accumulators, of educational controversy, of turbine and gas engine progress, of the dispersion of municipal fallacies, of big things at Manchester, and last, but not least, of fiscalitis. Progress and development there have been in all departments, but 1903 was not one of startling sensationalism from a trading point of view. If we turn to some parts of the country, however, we may even find that from a manufacturing and industrial point of view, there has been something of a backward tendency, and financial tightness and nervousness have been among the foremost difficulties against which the electrical manufacturer and the municipal Corporation have had to contend. And it does not seem, as we write, that the last has been heard of these retarding influences.

Some order books are well filled with profitable business, but there are others which have been filled with contracts obtained, apparently, for no other purpose than to keep works in operation. Reckless undercutting is to be deprecated in the strongest of terms. It despoils the undercutter and the undercut, and makes for the opposite of prosperity and stability in electrical manufacturing. Let there be competition in reason, but in 1904 pray let us have something more of reason in the manner of our competition. Other branches of our national trades may be in a more or less languishing condition, but when once the difficulties in the way of raising capital for the large schemes in power, traction and automobilism which are awaiting it are overcome, there should be no lack of work for manufacturers in the electrical and allied departments, especially now that the low-priced tenders of the foreign rival are at a greater discount in the public mind.

There is no need for us to make any attempt at summarising the whole story of electrical development up to date. Mr. Robert Kaye Gray, the honoured president of the Institution of Electrical Engineers, did this admirably for us a month or two ago in his inaugural address, which was published in our columns at the time. With that record of progress still in our mind the ELECTRICAL REVIEW wishes all to whom it reaches in every part of the world, a happy and prosperous New Year.

What is an Accident?

We had occasion recently to discuss the question, What is an accident within the meaning of the Workmen's Compensation Act? and we drew attention to a recent case in which a labourer who was struck by lightning while on a scaffold, was held by a County Court Judge to have sustained injury in an accident arising out of, and in the course of, his employment. We expressed the view that this was a somewhat extraordinary interpretation of the famous Act of 1897; but, to judge from certain cases in the Court of Appeal a few days ago, it does not seem to have gone too far. It has now been decided that if a workman catches an infectious disease while at his work, he is the victim of an accident! This point was raised and decided in two cases. It appeared that in the first case a man employed as a wool sorter was unpacking Persian wool. It is well known that the dust which comes from foreign wool sometimes contains the germs of anthrax, and it was proved that at the time in question the sorter was suffering from a sore place on his neck, through which the poison might have entered. He became infected, and being ill for some time he claimed compensation under the Act. In the second case before the Court, another wool sorter was proved to have become infected by a particle of dust which flew into his eye. In this case the County Court Judge held that there had been an accident. The Court of Appeal have upheld the decision, on the ground that they could draw no distinction between cases in which the accident was brought about by a visible cause, and cases in which the injury was caused by an invisible object, such as a microbe. It is fair to say that in giving this extraordinary interpretation to the word "accident" the Court of Appeal followed, and were bound to follow, a decision in the House of Lords, where it was laid down that disease shown to have been the result of an accident, could be made the subject of a claim. It is also fair to point out that the decision was here founded upon the uncontradicted fact that the infection was caught during the progress of the work. There was no dispute upon this point. We recall a case in which a man who alleged that he had sustained a rupture in the course of his work, made a claim for compensation. He had judgment; but the danger of admitting this principle lies in the fact that it will be possible for workmen who have sustained injuries of this kind, to come forward and state that they arose out of, and in the course of, the employment. In applying the doctrine that an infectious disease is an accident, the same difficulty will arise. Suppose, for instance, a man were to have an attack of typhoid fever. He might state that he became infected by drinking water in the course of his employment, whereas, in truth and in fact, the drains in his own house were out of order. In each case it will be a question of fact for the County Court Judge; but it is obvious that allegations may be made which the employer will find it very difficult to disprove. The moral we desire to point is, that the question whether there has been an accident or no is one which should be left to the County Court Judge to determine in each case.

Power for Large Machine Tools.

Mr. C. H. Benjamin, the American expert, writing in *Cassier's Magazine*, gives some interesting results of tests made upon machine tools at work and running idle. The tools were for the new steels and the driving was electrical. To run a 3-ft. boring mill idle required from 1·31 to 1·57 H.P. To run it at work required 2·12 to 3·21 H.P., the net horse-power per cubic inch per minute being 0·96 when cutting cast-steel. A 36-in. lathe which required 0·562 H.P. idle took a further 0·32 to 1·03 when working, or a net horse-power of 0·151 to 0·89 per cubic inch removed per minute. The rate of cutting was about 20 ft. per minute on cast-iron. No explanation is given of the great difference, which does not correspond with any apparent difference of other conditions. An 84-in. lathe on steel driving wheel tires was shown to take 10 per cent. more power when not cutting, but with work in place, than when the work was out of the lathe. The total power varied from 1·7 to 5·24, and the net from 0·05 to 3·58, the average being 3·02 and 1·37, the speed being 7·64 ft. per minute. About 0·9 cubic inch of material per minute per horse-power was removed. Various other machines tested seem to indicate that about one cubic inch of cast-iron is removed per horse-power minute; on inside or boring work, as little as one-fifth of this amount may be removed, but nothing definite seems to be yet determined. Motors apparently are much too large, and the horse-power taken when idle is half to two-thirds the full load power.

The practice of the shops where the tests were made would appear hardly up to English practice, which would, we think, show heavier cuts; but experiments are wanting to determine the power absorption of all classes of tools, and until more is known there will be wild guesses at the power required when electrical driving is being installed. If the illustrations of the chips made by the tools in the Lake Shore shops are full size, they must be playing at machine shop. But we fancy these chips have been reduced photographically and the scale forgotten.

Electrical Canal Haulage.

One of these days, we hope, there will be a general awakening to the iniquity of permitting the consumptive waste of capital now proceeding in the canal system of England. Regarded on the map, without relation to the names of owning companies, the system is magnificent in its extent, but it needs no words of ours to prove how different is the reality. Save in a few instances, not only have no improvements been made, but the properties have been permitted to depreciate in every way. The consequence has been that railway rates have shown practically no decrease for the last 30 years, although economy obtained in working has been marked during that time.

Unless an Englishman lives near one of the large manufacturing cities, he thinks of canals as unkempt strips of dirty water, over which it is almost possible to jump, and in which it is difficult, under ordinary circumstances, for a man to drown. The state of disrepair of the tow-path is looked on not with wonder but as a matter of course, and the canal itself is considered much more as a fish-pond, or a handy place to drown superfluous cats and dogs, than as part of the national waterway. The meditative angler swears if an ugly barge sweeps his water once an hour, while the passing of a steam barge towing its string is contemplated with a similar distaste to that evinced by Mr. Briton Riviere for the motor-driven or drawn vehicle in the London streets. The thought does not enter the head of Piscator that a better dinner might be awaiting him, and a healthier wife and children, if the traffic on the canal were such as to render fishing impossible, for directly canals are maintained properly, and run for what they are worth, not only is a cheap method of transport given to traders, but railway rates are forced down to a more natural level, and competition with the world is rendered more effective.

Dwellers in large towns may appreciate better the value of the silent road, but few Englishmen realise that there are 3,500 miles of inland navigations within their bounds. This represents a greater mileage than the whole of the electric tramways in Great Britain. It is notorious that the chief cause of the semi-stagnation of these waterways lies in one-third of the whole being owned by the big railway

companies; but the development of through traffic is hampered much by the sub-division of control. For instance, Mr. H. Gordon Thompson states ("The Canal System of England") that sending freight from London to Liverpool involves passing it through the hands of from 7 to 10 different companies and navigations, according to the route followed, whilst other through routes are complicated to a greater or lesser extent.

Until extensive amalgamation of interests takes place it is obviously impossible to do much towards making the whole system efficient. The inherent evils of State control and ownership would be far better for the nation than the existing state of things; but the State is so much employed in other ways that it would be nothing less than a miracle if it turned its attention, more than by way of a Royal Commission or Joint Committee, to the salvage of an unnaturally stifled system of cheap transport.

Wherever in America, or on the Continent, canals have been taken seriously, they have proved profitable in themselves and beneficial to traders throughout the country, on account of the low rates they have been able to offer, and the lower rates the competing railways have been forced to give.

The French have seen the advantages of an efficient canal system, and have already some 300 to 500 miles under some form of mechanical haulage, while the Senate has voted lately a matter of 300,000 francs for the improvement of canals and navigable rivers.

In England, up to the present, very little effort has been made to keep the existing canals clean, much less to widen and deepen them and the locks, or to supersede the scraggy horse by a more modern tractor.

That electric haulage would revivify our canals we have good hope, so long as some even more pressing reforms are carried through first; but we dread to think that the fact of the through routes being in so many different hands will render agreement as to the proper system as difficult a matter as that on which the Metropolitan and the District Railways wasted so much time and money. We trust that a jumble of systems will never be permitted by the Government; but the danger is that the system adopted by the pioneer will not be sufficiently perfect to make its adoption by others either easy or prudent.

Duplication of Supply.

THE recent dilemma in which the electrical authorities of the city of Bristol have been so unfortunately placed, brings up a question of more than ordinary importance in connection with electricity supply work. As our readers are well aware, it has become necessary for many of our more energetic supply authorities to embark on extensions of their original plants by reason of the rapid growth in the demand for electricity for power purposes—a feature which was not contemplated by the original promoters, and does not appear to be fully realised even at the present day. These extensions, as a rule, take the form of a new generating plant of more economical proportions, and located on a less restricted site than in the case of the original works, and this is practically always followed by the coupling of the new source of energy to the old station for distribution through the original switchboard, a natural enough proceeding, at first sight. The crux of the whole situation in regard to reliability, however, then lies in the original distributing board, for if this fails through any cause, the duplicate source of supply, which otherwise forms a most valuable feature when serious breakdowns occur, becomes for the time absolutely useless. The principle of duplicating plant and appliances in individual stations has received ample consideration at the hands of engineers—indeed, many will say the matter is overdone, in view of the tried qualities of many classes of plant; but the question of arranging for two independent sources of supply in cases of emergency, does not seem to have gained the attention that it certainly deserves. It is to be hoped that the unfortunate distinction which Bristol has achieved will prove rather a blessing in disguise, in that others may profit from the experience there gained, and that such occurrences, now happily rare, may become things of the past.

THE DESIGN OF DIRECT-CURRENT MACHINERY.

BY VAL. A. FYNN.

(*Continued from Vol.* 53, *page* 1049.)

THE length of the air section is ascertained as shown in fig. 18, which explains itself, illustrating the allowance made for air duct.

The width is computed on the same lines, it being assumed that the magnetic flux is uniformly distributed along the pole face and radiating from the armature teeth, leaving above the slots triangular spaces, assumed for the

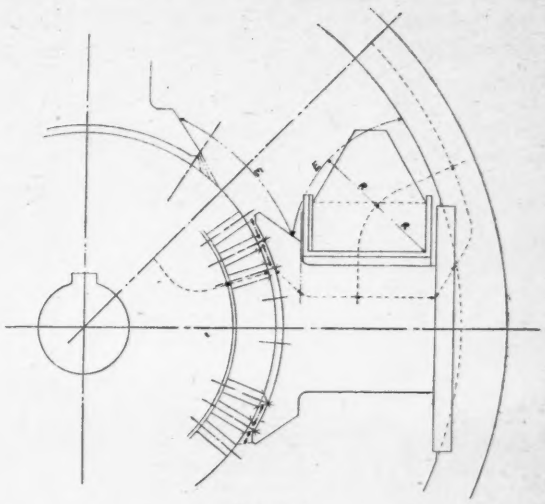


FIG. 17.

moment to be free from magnetic lines. As far as the writer has been able to ascertain, this method holds good as long as the distance between pole face and armature periphery is not less than half the slot width. When the air-gap becomes smaller the flux is no longer uniformly distributed along the pole face, but the latter shows parts, immediately above the

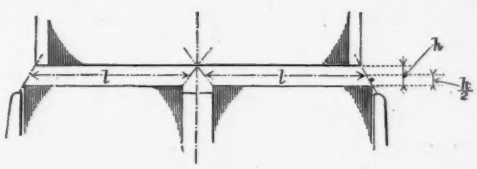


FIG. 18.

slots, free from lines. It has been the writer's practice to allow for this by assuming the point of convergence of the lines radiating from neighbouring armature teeth to be situated within the pole face at a distance from the armature equal to half the slot width. The heavy lines in fig. 17 show the widths of the various sections, which must be added together to obtain the total air width for each position. The mean of the two widths is taken for the calculation. It is important to choose the slots in such a way that the difference for the two extreme positions becomes as small as possible, as otherwise a very marked pulsation is felt through the whole system, causing excessive heating and consequent loss. The very disagreeable hum often produced by such motors is also often caused by this variation, and under favourable circumstances, that is, when its period is a multiple of the armature cycles, it may rise to a very shrill note with the above variation still within 10 per cent.

The width ascertained in this way is too small—we have to add a correction for the leakage lines reaching the slot walls; this can be done by making use of Mr. Parshall's suggestion for ascertaining the true density in the armature teeth. The correction naturally takes the form of a percentage added.

D

In Table I. are given the corrected densities for the slot proportions such as are made use of in the series of machines we are considering, and on the assumption that 12 per cent. of the armature length is taken up by insulation. No allowance is made for air ducts, as none are used.

The curves, fig. 19, illustrate this same table, the theoretical densities, B^1, per square centimetre being plotted

TABLE I.

Table showing true densities per square centimetre in the iron teeth of slotted armatures without ventilating ducts, and where 12 per cent. of the length is taken up by insulation:—

True density, B	μ	$\frac{a}{b} = 1{\cdot}5$	$= 1{\cdot}25$	$= 1$	$= {\cdot}75$	$= {\cdot}5$
17,000	169	17,100	17,100	17,130	17,170	17,250
18,000	96	18,180	18,200	18,230	18,300	18,460
19,000	38	19,450	19,520	19,650	19,830	20,200
20,000	23·4	20,750	20,900	21,100	21,400	22,100
21,000	17·4	22,100	22,300	22,500	23,000	23,900
22,000	14·1	23,400	23,600	24,000	24,600	25,800
23,000	12	24,700	25,000	25,400	26,200	27,700
24,000	10·6	26,000	26,400	26,900	27,800	29,500

against the true densities, B, for the various ratios of tooth width to slot width.

The theoretical density is the one which corresponds to the assumption that the teeth carry all the flux. The slot width is designated by (b), the tooth width by (a). The difference between this theoretical and this true density can be further made use of for the predetermination of the

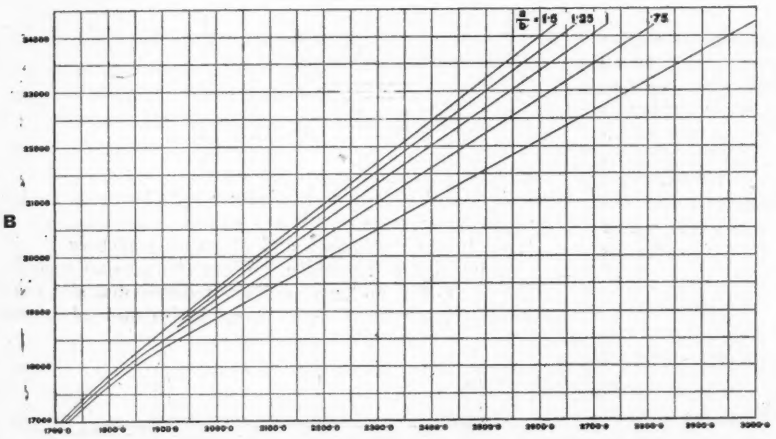


FIG. 19.

[Apparently the decimal points should be omitted from the figures for Bl.—EDS.]

probable Foucault current losses in the armature conductors.

The useful leakage coefficient outside the pole face can now be ascertained with the help of the lines we have drawn for the purpose (see fig. 17) as representing the mean lengths of leakage lines, by means of the following formula—co-

$$\text{efficient of useful leakage} = \frac{1}{1 + \frac{\text{magnetic gap a side}}{\text{half the air width}} \times a},$$

where a is the sum of the reciprocal values of the mean lengths of leakage lines measured in centimetres.

The magnetic air-gap, always longer than the mechanical, for a slot armature, is arrived at as shown in fig. 20, and that value is used throughout the calculation.

The "transition sections" already dealt with by figs. 5, 6, 7 and 8, should always be carefully considered in order to avoid useless checking of lines.

This really represents the most important part of the magnetic circuit calculation; the other items are absolutely simple. Having obtained all these figures, it becomes possible to tabulate the results, putting against the various areas, the corresponding lengths of the magnetic path (L) as taken from fig. 17, and also the corresponding leakage coefficient (V) for the stray field.

It must be admitted that we can offer no useful formula for the predetermination of this stray field; the writer has tested many that have been put forward, always with very indifferent results. One and all require so much judgment and experience in order to obtain anything like correct results, that it seems to the writer best and quickest to rely on one's judgment and experience altogether for a first approximation, and as soon as the first machine of a type is built, to obtain the true figures by means of exploring coils. The changes necessary from size to size and with altered air-gaps, are then, of course, quite easy to make. All the leakage tables we have so far seen in text-books must refer to very large air-gaps indeed, as they greatly exceed the figures we have found by actual test. These tables would be so much more valuable if the corresponding air-gaps were stated.

For the series of machines under consideration, the leakage at the worst point never exceeds 15 per cent.

Referring to fig. 17, we shall find the greatest density at the root of the pole, whence it will gradually diminish along the frame and towards the air-gap. In order to ascertain what length of path it is fair to allow for this maximum density, we must find that point along the pole at which the leakage path from pole to pole equals the leakage path around the highest and innermost turn of the exciting coil to the frame. Beyond that point the value found for the leakage from pole to pole must be used; within that point, the pole may be divided into two equal lengths, the top half can be considered as carrying the full flux, the lower half as carrying an intermediate value. This distribution is indicated in the figure.

Having figured the total volts lost in armature, commutator, brush-gear and leads, we can ascertain the total ampere-turns required in the usual way, and after putting on record the total armature ampere-turns (AT_a), the ampere-turns per centimetre circumference (AT_c), the ampere-turns per pole (AT_p), and what we call the "load" or the ratio ampere-turns required to overcome the air-gap resistance over armature cross ampere-turns, we can proceed to calculate the exciting coils.

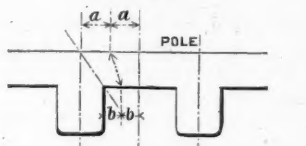


FIG. 20.

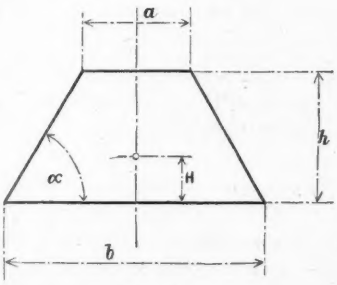


FIG. 28.

As a rule, the ampere-turns per coil required are known, also the voltage at the coil terminals. When we deal with a standard line of machines, the overall dimensions which the field coil is not to exceed are also settled. The diameter of the wire therefore remains to be found; a very useful formula giving very accurate results is the following:—

$$\text{Diameter in mils} = \sqrt{\frac{a \times AT \times b}{\text{volts}}}$$

a is a constant = 1·5 for round and = 1·9 for square or oblong formers; b for round coils is the sum of smallest and largest diameter in inches, and for oblong coils it is the sum of the arithmetrical mean between the minimum width plus the minimum length, and the maximum width plus the maximum length, all measured in inches.

Should the cooling surface per watt work out too small with the overall dimensions assumed, these must be adjusted to suit. Small alterations have practically no effect on the diameter of the wire.

When field coils are of a conical shape, it is not always convenient to get at the mean length of turn by construction. The following formulæ make it possible to arrive at the distance from the base at which the mean turn is situated.

We have designated this distance by the letter H in fig. 28—

$$H = \frac{h}{3}\left(1 + \frac{a}{a+b}\right).$$

Should a not be known, we can easily determine it with the help of the angle α, which gives the steepness of the cone—

$$a = b - \frac{2h}{tg\,\alpha}.$$

It only remains for us to deal with the predetermination of the various losses so as to enable us to estimate the final temperature rise in the various parts of the machine as well as the efficiency.

It is by no means difficult to predict what the losses ought to be, but it is quite another matter to make absolutely certain that the anticipated values will not in reality be exceeded. This is more particularly true where the iron losses of a machine are concerned. The copper losses are easy enough to predetermine. There is, of course, a loss due to the resistance of the circuit, and in addition in some special cases the loss due to Foucault currents, even when the conductors are embedded in slots. When discussing what we termed the useful leakage, we pointed out how those values could be obtained.

Very elaborate, and theoretically certainly quite correct, formulæ have been proposed for the predetermination of the hysteresis and Foucault losses in the teeth of a slotted armature. The writer prefers in his practice, in view of the uncertainty referred to, to make use of handier, if less accurate, formulæ. The initial properties of the iron, as supplied by the wholesale dealers of that commodity, may not vary appreciably, but these properties are influenced to an enormous extent by the subsequent handling to which it is exposed.

Supposing even that the safest course is adopted, viz., that of thoroughly re-annealing the armature stampings after they have been punched, a considerable risk is still run of materially increasing the losses during the building up operations. It constantly happens that these discs do not assemble with sufficient accuracy, sometimes the teeth require to be straightened, sometimes they require touching up with a file, and in very bad cases a milling cutter has to be run through the slots. Under such conditions no amount of care and time expended in exact calculations will give true results.

(*To be continued.*)

METHODS OF CHARGING FOR ELECTRICAL ENERGY.

THE very clear and complete exposition of the Tariff Question, as expounded in his paper entitled as above by Mr. Ellis H. Crapper before the Leeds Local Section of the I.E.E. on the 17th, is valuable alike to the student and the central station engineer. Mr. Crapper recognises at the outset the complexity and vastness of the question he is dealing with, the discussion of which is almost as perplexing, inconclusive, and indefinite as any attempt to argue the other tariff question; he therefore confines himself almost entirely to a general summary of the methods of charging, obsolete and now in vogue, although he is rather modest regarding the valuable and interesting information he gives, in the appendices and elsewhere, for the use of those who wish to tackle the problem quantitatively. No doubt a great obstacle in the way of popularising the scientific treatment of the electric tariff question is the ignorance of the consumer on the subject. To the ordinary business man, who is used to "obtain a reduction on taking a quantity," and who recognises this as a law of the Medes and Persians, it must seem extraordinary to be asked to pay a higher rate for taking a large quantity of electricity for a short time than his neighbour who takes a smaller quantity for a longer period. Yet this is what all the systems based on the Hopkinson principles amount to, and theoretically these systems, no doubt, more nearly and fairly apportion the cost than any flat rate system can do.

We used the term "clear" advisedly in referring to this paper. It is a paper that should be read and studied, and if a reprint of it were sent to consumers, it is not too technical for those of average business capacity to understand, whilst it might work for good by clearing up many misconceptions and misunderstandings in regard to the maximum demand system. To central station engineers, as a *résumé* of the whole question, and as containing useful hints, it should be most valuable; we cannot do better than quote some of the author's axioms and principles, in which he defines the various phases of the problem.

The ultimate objects of the engineer may be briefly stated to be as follows:—

1. To produce electrical energy as cheaply as possible.
2. To supply electrical energy as, and when, demanded.
3. To evolve a system of charging for electrical energy equitable to all concerned, and thus enable electricity to compete with its competitors, gas, steam, &c., and at the same time to produce a profit.
4. To popularise and encourage the use of electricity for as long as possible, and for as many purposes as possible.

The complete problem involves several distinct elements, viz.:—

1. The accurate determination of the cost of supply, including every item of expense.
2. The apportionment among the individual consumers of the items of expense, not directly proportional to the cost of the production of the energy supplied.
3. The elaboration from the data at hand of a tariff equitable both to the undertaker and to the consumer.
4. The popularisation and acceptance of the system thus devised by the public.

The following are some generally accepted theorems:—

(*a*) It is more profitable to sell continual use of the plant than kilowatt-hours.

(*b*) The theory of equity requires that each kilowatt-hour sold should bring a uniform profit to the undertaker.

(*c*) A rational system of tariffs must be based upon, and be in conformity with, the costs curve of the station, from which it is clear that the charges made for the energy supplied must be graded, and not uniform.

(*d*) In the case of a long-hour consumer of h hours consumption, the *readiness-to-serve* costs are distributed over h times the number of units as compared with a one-hour consumer, provided each takes the same number of kilowatts.

(*e*) The price charged for a commodity controls to a great extent the demand for it.

(*f*) The more diversified is the demand, both as regards nature and period, the less pronounced will be the peak load.

Dealing with the uniform meter rate, an interesting table is given of proposed "seasonable" discounts proposed to be given to consumers at Buda-Pesth, as set forth by M. de Fodor before the Paris Congress in 1900, the largest discount being, of course, for the summer months. We hardly think that, if this system educates the public to understand the advantages of electric lighting during a period of low tariff, the extra trouble in preparing the accounts should be allowed to weigh against its adoption. This is only a question of clerical organisation. The method once in use at Ayr is also quoted, under which discounts were given according to the duration of consumers' demands. But Mr. Crapper will have none of these systems, and no doubt he is right, as they do not take into account the rate of supplying energy in connection with the time element.

Of two-rate meters he is sceptical, or perhaps we should say condemnatory. But his criticisms appear to be levelled chiefly against apparatus designed to register fast or slow, by the insertion of resistances or other devices. These are all open to objections, particularly in regard to the veracity of the meters; but he leaves out of account the Aron two-rate meter, which consists of two trains of wheels, each actuating a separate dial. By means of a clock switch, and with the consent of the consumer, one or other of the dials can be made to register for any length of time during every 24 hours, the other being cut in at the end of that period and so on. If the two dials represent different tariffs, here we have a case where the consumer knows exactly when he will have to pay higher or lower rates, and how much he is liable for on account of each. But Mr. Crapper thinks the two-rate system unsound, as it "tends to flatten the load curve by

reducing the peak instead of building up the low load curve." Surely this is a curious way of putting the case. If the peak be flattened by this system, the area removed will be added to the valleys and the load factor increased. What is more, if the system be combined with a power tariff similarly arranged, the danger of "overlapping" will be reduced, and the valleys are likely to be filled without adding to the peak for a given number of consumers.

Again, if the capacity of a station bears a certain ratio to the peak demand, and the building up of the low load curve only is aimed at, then for all new lighting consumers connected the peak will continue to rise, and new plant will always have to be installed to maintain this ratio. The low load curve can only be increased by power users, and the ratio of capacity to maximum demand will never thereby be decreased. This increment is an important one which earns no interest on capital outlay, and it can only be reduced by filling the valleys at the expense of the peak. Such a landslip would defer the ordering of new plant, and a flat peak, if this be not a paradox, could be allowed to more nearly approach the capacity level than a pointed peak.

In the Wright system, Mr. Crapper thinks we have approached the ideal system more nearly than with any other, but he points out its imperfections:—(1) That when the consumer intends to exceed his normal maximum demand, he can have the indicator short-circuited by giving notice beforehand; and (2) that it is not understood by the layman. The latter is a serious objection, but to many who have seen the descriptions of the method of charging as printed on the back of some meter cards, there is small wonder at this want of understanding. The writer of this article has seen smart business men give it up in despair. How, then, can it be expected that the average consumer will understand? And ignorance is always the great stumbling block to progress.

In dealing with the power question, the author wisely advocates selling the continuous use of plant, even at a minimum rate per kilowatt, rather than to permit 70 per cent. of the plant to remain idle. He points out that these rates must be cut to compete with gas and steam power, but it is better to do a large turnover at a small ratio of profit than to have a small turnover with a large ratio of profit. In mentioning the overlapping difficulty, he points out the good results obtained in Canada, where such low rates are offered to manufacturers during daylight hours, that they find it to their advantage to shut down before the lighting load comes on. This, we think, bears out our previous remarks regarding the two-rate system. But the whole power question is one requiring considerable forethought, and station engineers in manufacturing districts will, as Mr. Crapper says, have to exercise tact, business capacity and good management. What is more, better attempts must be made to educate the manufacturer, by personal canvassing, and the judicious issuing of concise literature.

The tramway question is touched on in connection with mixed lighting and traction loads, as showing that these are beneficial to stations with a low average income per unit, which cannot be doubted. The paper concludes with two very important points affecting the settlement of the charging question. Taking the last first, the efficiencies of the electric glow lamp and the radiator are low compared with the incandescent mantle and gas stove respectively. This fact enables the gas companies to compete successfully, and retards the growth of electrical supply. The other point is the wiring problem. The small consumer would solve the electricity supply question, perhaps sooner than the increased efficiency of lamps and radiators, if he could only be "roped in." At present he is the mainstay of the gas companies, and so he will remain until the landlord undertakes to wire new houses in the same manner as he supplies the gas pipes at present. Whilst this is already being done by many landlords, the principle has hardly been extended to small property. If the landlords were asked the reason they would, no doubt, say that it is cheaper for them to install gas. It therefore looks as though the more general distribution of electrical supply rests on the shoulders of those interested in the manufacture of lamps and wiring supplies. Let us quote Mr. Crapper once more:—"The sooner the growth of the electric light business is such as to affect the supply of gas, the sooner will the question of charging settle itself." It is to the manufacturers then, that we must look for such improvements as will bring about the Utopian flat rate.

It is impossible, with the space at our disposal, to deal with the contents of the appendices. Engineers should obtain a copy of the paper and particularly study Appendix I., which explains the application of elementary principles to determine the price of electricity. In conclusion, Mr. Crapper is to be commended for tackling this difficult subject in so able and, as has been pointed out, in so lucid a manner.

A METHOD OF LOCALISING FAULTS IN HOOPER'S INDIA-RUBBER CORE.

By HAROLD OHLSON.

Among the various experiences of the electrician in the cable factory, may sometimes be found the necessity of localising a fault in india-rubber core after it has been covered with yarn or metal tape; occasionally this fault is of high resistance, and cannot be broken down for the purpose of a loop test, even when subjected to great electrical pressure while immersed in water. The method of passing the core through a bath of water or a wet sponge, connected to earth, and watching for a decreased resistance in the fault, is at all times more or less unreliable.

The method usually employed—that of coiling from one insulated drum to another, and testing at intervals by comparing the leakage through the dielectric of the two parts of the length by alternately earthing and insulating each drum—is accurate, but tedious, and necessitates breaking the covering of the core for each test in order to insulate one drum from the other, the covering being a conductor.

The following method will in most cases indicate the exact position of the defect far more quickly, and does not require the covering of the core to be broken.

The length should be slowly passed through a bath of water or wax at a temperature of about 200° F., and the leakage through the dielectric carefully noted by the deflection of a sensitive galvanometer, using as large a battery as possible. Immediately the fault enters the hot bath, the deflection on the galvanometer scale will begin to rise owing to increased leakage through the fault. It will fall again as the fault passes out of the hot bath, so that the operation may be performed several times over the suspected place to obtain an exact localisation.

To ascertain the effect of the hot water on an imperfect joint, the following experiment was carried out. Two joints were tested under water with 1,200 Leclanché cells, and the leakage noted in divisions on the galvanometer scale. The following results were obtained, one scale division representing approximately two million megohms:—

Temperature in degrees Fahr.	Leakage in scale divisions. Joint A.	Joint B.
60	¼	1½
90	¾	3
120	1½	7
60 (after heat test)	¼	1½

These joints were made abroad in old india-rubber core before it was returned for re-sheathing, and were selected to show clearly the effect of the hot water.

Thus the joint A in the hot bath would have caused the deflection given by the whole length to rise 1¼ scale divisions only, while the imperfect joint would have increased it 5½ scale divisions, a difference easily detected. If the joints are suspected, it is only necessary to plunge each into hot water, and note the proportional rise in deflection. It is also apparent that with a lower battery power or less sensitive galvanometer, the two joints, A and B, might have seemed to be of equal dielectric resistance if tested by direct loss in water at 60° F., but on raising the temperature to 120° F. the difference is very marked. Thus, by testing at a high temperature, an imperfectly made joint, which may possibly continue to fall in insulation, can be more easily detected.

The writer has had this method of localising defects in india-rubber core in practical use for the past three years,

and has found it invariably successful. Besides faults of low resistance, due to injury, the most minute imperfections are exactly localised by its means if it is carefully performed. Even in cases where the defect has only been apparent by a slight decrease in the rate of electrification when testing with 1,200 Leclanché cells, giving a galvanometer constant of over two million megohms, and the dielectric resistance of even such short lengths as 1,000 or 2,000 yds. has been very little altered by its presence, the method described has never failed to localise the defect within a few inches, without breaking the covering of the core.

THE FUTURE MACHINE TOOL.

THE extraordinary development of tool steel which has taken place in the last two or three years, and which culminated in the Manchester tests by Prof. Nicolson, has had the effect of consigning to the scrap heap a very large number of tools still good and new. Americans, who have for years on insufficient grounds been crying out for the rapid scrapping of tools, more, we fear, because their tools had no durability, and had to be scrapped owing to being worn out, long before they were obsolete in design, may well hail the new steels as a justification of their policy, even though it be the first.

The light cuts and quick speeds which American practice has favoured in the construction of machine tools was, perhaps, perfectly justified when working on the easy constructional material, which has been so marked a feature of American practice. But our harsher material, not, perhaps, always wisely employed, has been better dealt with by heavy cuts at less speeds. The new steels more than ever are suitable for heavy cuts, and the inevitable change in machine tools which the new steels are compelling will come less severely on English than on American tool makers. The last few years have revolutionised the English tool makers, who certainly needed waking up, and they appear to have awakened just in time to be ready for the new movement.

Prof. Sweet, in America, has taken up the subject of new designs. He realises the stiffness of the box form of framing; yet how few, he says, have adopted the box form of lathe bed, a structure whose duty is to resist torsion. So, too, with planer beds and tables, in which he would also put the slots crosswise instead of endwise.

The cross rail of a planer or of a boring mill should also be of box form. He points out certain things in connection with the over-running of a platen on its bed, and from his own engine practice, illustrates where he has found it necessary to let the cross-head over-run half the length of the block before the scraper marks show uniform wear. Besides stiff frames and beds, the drive of a machine tool must be changed. He hints that well-designed worm gear might find a place in the driving of a machine tool, and we are far from thinking him wrong. Experience has also shown him that too much trouble may be taken over the design of a worm. He thinks the Hindley worm gear need never have been invented. He says a liberal pitch worm skewed round to mesh with a plain spur wheel, or one with the teeth at such an angle as to skew the worm a little more, will run more easily, and last longer than the other sort. Probably this is because the plain gear is driven by straight pressure, for the instantaneous line of action of a skewed worm is, of course, normal to the axis of the driven wheel.

For lathes, he recommends large and short main bearings, and a large box face plate as big as will swing over the bed. He condemns precision screws in a lathe, for they at once wear, and are then no more precise than an ordinary screw.

This tirade of the Professor, as he himself calls it, is practically a rebellion against established habits of machine tool men; a call for more simple and stronger machines to do one thing well. Prof. Sweet has long been known as an expert mechanician, and he has rarely been wrong. He has travelled and seen much and observed well, and he has been one of the few Americans who have perceived that our English practice in engineering matters has not been all hopelessly bad. English machine tool makers will read his paper, which is presented this month before the American Society of Mechanical Engineers, with interest. If American designers begin to use better frames and beds, and are not so close-fisted over a pound of cast-iron here and there, their products may still compete over here even with the new steel conditions, but with heavier and better designs we may also expect that the dump prices to which we have become accustomed will also, to some extent, disappear. After all, a low-priced American lathe or planer, however accurate when new, and on the shop test, is of precious little use if its wearing parts are so light and soft that, like a so-called precision screw, they go out of shape with the stress of actual work.

SYSTEM OF LIGHTING H.M. SHIPS.

THE lighting circuits on board a ship of war, it would at first sight appear, might with advantage be run on a single wire system, using the ship's hull as a return, and when the electric light was first introduced into the Royal Navy this was the method adopted.

A very slight experience, however, soon showed the necessity for an insulated return, especially when high-voltage alternators were brought forward for trial, and even with low voltages the continual wear and tear and the ever present moisture at sea soon found weak places in the insulation.

Consequently, the return wire was put in at the sacrifice of economy in wiring in the first instance, with the result that it paid for itself in the long run by saving in repairs and the necessity of rewiring where small leaks had started mischief, which steadily advanced in spite of all efforts to keep it down.

The electric lighting cables at present in use are all lead-covered except those for use with portable lights, which are usually braided over with phosphor bronze wire. The insulation is composed of pure india-rubber next to the copper core, over which is wound india-rubber coated tape, the whole being generally vulcanised together. In the older circuits a braiding of hemp yarns was considered sufficient protection, but it was found that moisture worked its way in and rotted the outer covering, with the result that the rubber became exposed, and in course of time deteriorated by oxidation; this showed the necessity for lead covering, all joints being carefully soldered together so that there is no chance of damp getting in and "creeping."

With all these precautions, however, leaks do occur, and a party of men in charge of a petty officer are constantly occupied while the ship is in commission going round the decks "chasing earths." When it is considered how many circuits and branch wires there are in a man-of-war, it is hardly surprising that a comparatively perfect insulation from the ship is seldom of long duration.

Ships are lighted either on the branch or ring system, the latter being fitted in all the newer ships.

The advantage of the ring system lies in the fact that a rupture in the mains such as might occur in action, would not put out the lights in a distant part of the ship, for the mains are led round the ship's side under the armoured deck, and thus if the cable on one side was badly injured, the lamps beyond the break would be fed by the main running round the opposite side of the deck with only slightly decreased brilliancy.

In important places, such as the magazines, failure is in a great measure provided against by running half the lights off one branch, and half off the other, the mains being distributed as far as possible on both sides of the deck.

As regards the distribution of current, the dynamo room is, as a rule, situated close to the engine room and below the armoured deck, it contains at least two dynamos, and there will be for greater convenience and easier accessibility, a third dynamo, known as the peace dynamo, in consequence of its being above the armour. Only one of these is used for ordinary lighting, one of the others being kept as a standby, in case of an extra load, such as searchlights and whatnot. The third will probably be under repair or examination.

The mains run straight from the dynamos to the various bars on the switchboard, and are known as the dynamo mains, to distinguish them from the supply mains. Every dynamo has its pair of bars so that there is no common return. Large fusible cut-outs are fixed in each dynamo main and leads are taken from the bars to a common voltmeter, with a three-way switch.

There are two kinds of switchboards in general use, the later pattern consisting of a series of vertical spindles with projecting tongue pieces, which form the contacts for the particular circuit which the spindle represents.

The spindle is revolved by worm gearing and a key, so that the circuit can be revolved into contact with any pair of dynamo bars required, and a tally on the face of the spindle shows which particular pair of bars are doing the work in that circuit. The circuit is made or broken by a chopper switch and spring release, and fusible cut-outs are inserted in both the main and return terminals.

There will be perhaps half-a-dozen of these circuits on a board with main and return leading away to the cut-out boxes, which consist of six brass blocks, the three upper blocks being positive, and the three lower ones negative; consequently the mains come into the centre blocks, and the current divides through fusible cut-outs again, which bridge between the blocks on either side. From these side blocks the sub-mains are led, and, if we are considering a mess-deck, for instance, they will be led right round the deck, one on each side, and, if wired on the ring system, they will eventually, of course, be joined at their further extremities, otherwise they will be led away independently as far as required.

Following one of these sub-mains along, we find that it leads into a circular aluminium sectional box with a screwed lid, for dividing the circuit up into sections. The sub-main runs right through the box and out at the further side, being represented in the box itself by two brass strips, to which is attached a double-pole switch which controls all the branches in that particular box, of which there are four. These four branch circuits are connected through fusible cut-outs on both positive and negative sides to the switch-blocks, and proceed out from the box to their respective "distributing boxes," which are of a similar character.

Following one of these branch circuits we come to its distributor box and find a very similar arrangement, only the switch in this case is designed to cut out the whole of the supply through that branch, as this is practically the termination of the branch we have been following; it ends in two semi-circular brass strips from which proceed small fusible cut-outs, which feed individual lights, or in some cases small cut-out boxes which in turn feed a pair of lights.

Thus, each distributor box controls its group of lights, eight in a group, except where small cut-out boxes are used, when as many as 16 lamps can be controlled from the distributor box.

Having followed one of the branch circuits from the sub-main to the lamp it feeds, we will return to the main circuit and trace it to its terminus.

From the first section box it passesion to a second, and from this on to a third, delivering up a portion of its energy to each system of branches as it passes through, until finally it terminates in the last box, and this ends one side of the particular circuit under consideration unless, of course, the ship is wired on the ring system, when the two terminal boxes will be joined together. All these sub-main cables are lead-cased and built up of copper wires No. 20 standard gauge, and contain from 550 to 15 strands, according to the work required, this represents a current-carrying capacity ranging from 450 to 12 amperes. Branches leading to distributor boxes contain 11 strands of the same gauge wire, and carry about 9 amperes.

The distributing leads are made from single copper wires No. 16 or No. 19 gauge separately insulated with rubber and lead cased, and are capable of carrying 2·5 and 1 ampere respectively.

The carrying capacity is calculated at a fall of 2 volts per 100 yds. run, and the cable can easily carry without injury double the normal amount.

The voltage in general use in the Navy is 80, a pressure originally selected as being the best for running the searchlights.

The lamps in general use are 16 c.p., taking ·8 amperes of current, and offering a resistance of 100 ohms when hot.

In certain cases, where only local illumination, such as in telegraph or compass indicators, is required, 8 c.p. lamps are used, and a few 50 and 100-c.p. lamps are supplied for special purposes.

Cut-out fuse wire is supplied in three sizes, which will safely pass currents of 85, 20 and 8 amperes respectively.

At first glance it may seem rather superfluous to put in so many cut-out fuses as are used in the naval system of wiring, especially in placing cut-outs in the return wires, but cut-outs form very convenient means of breaking either side of the circuit when testing for leaks, which testing is carried out first on the switchboard to ascertain the defective main, then in the sectional and finally in the distributor boxes, from which the defective lead can be traced, and the fault found either by examination or testing.

It is in this testing that the fusible cut-outs come in handy, for, as they are easily removed, any branch or number of branches can be quickly isolated, or all the cut-outs can be removed and replaced one by one until the fault again appears, showing that the last cut-out put in was on the affected circuit.

Bayonet-joint lampholders are at last coming into favour with the naval authorities, but they are found not to stand vibration nearly so well as the old spring-hook contact, for the reason that the plaster in the cap is liable to crack and work loose, especially during gun fire.

All lamps are protected by a thick watertight glass covering, which is kept tight up against a rubber ring, by a screwed brass rim. Places where leads enter or emerge from any of the fittings are likewise made watertight, small screwed glands being fitted for the purpose, and the lead covering soldered to the body.

ELECTRIC RAILWAYS IN EUROPE.

Safety Precautions for Underground Lines.—The Promotion of New Schemes.

The Berlin police authorities have now held a further conference with representatives of the Elevated and Underground Electric Railway Co., Messrs. Siemens & Halske, and others, for the purpose of settling the precautionary measures to be taken with a view to obviating an accident in Berlin of a similar character to that which took place in Paris a few months ago. A reference to the Electrical Review of September 4th last, will show the provisional steps taken in this direction. It is now necessary to state that the additional precautions which have been decided upon, relate to the projected extension of the Berlin underground railway from the Potsdam railway station to Hausvogtei Platz and the Spittelmarkt. It has been agreed (1) that the stations shall be naturally lighted (have daylight) from the entrances and exits; (2) that all stations are to be provided with emergency exits; and (3) that at definite intervals along the sections there are to be arranged shafts which will not only allow of the escape of vapour or smoke, but also permit the fire brigade and the public to enter or leave the tunnel sections without danger.

The suspended railway at Elberfeld has been inspected by the Berlin Municipal Highways Committee as a result of the proposals submitted by the Continental Co. for Electrical Enterprises for the construction of similar lines in the German capital. At the request of the committee the company has now expressed its readiness to hand in detailed plans, but it has declined the suggestion to build an experimental length of line on its own account. The company is, however, prepared to construct the trial section provided that a contract is previously entered into authorising it to build the entire railway in the event of the section meeting with the approval of the committee. It is estimated that a trial length of 330 ft. would involve an outlay of £2,500 to £3,750. The question now awaits developments.

The rejection by the Hamburg Municipal Committee of the proposals put forward by the Senate for the construction of an electric railway in the city, at an estimated cost of £2,000,000, once more opens a prospect of a competition being instituted between the leading companies for a concession to build the line, which, according to the Senate, should be an underground one. Complications have, however, been introduced by the Committee having left the question open as to whether the railway should be subterranean or on the Elberfeld suspended system. In this connection, Profs. Barkhausen, Dolezalck and Hotopp, of the Hanover Technical High School, who had been authorised to report on the subject, now decide definitely against an underground railway for Hamburg, but emphatically in favour of the Langen suspended system from all points of view. This report, which differs entirely from that prepared by Hamburg experts, has caused a considerable amount of surprise in that city, and it is said to enhance the prospects of the overhead method as promoted by the Continental Co. for Electrical Enterprises of Nuremburg. Nevertheless, it seems probable that the ultimate result will be found in applications being made to the rival companies, to submit fresh schemes to meet the requirements of the town.

The scheme for the construction of an electric railway between Brussels and Antwerp, which has been before the country in various forms for several years past, has now nearly reached a stage which should bring it to a practical issue. The Senate has already expressed itself unanimously in favour of the immediate building of the line, the interested Chambers of Commerce support the scheme, and the public demands that it should be proceeded with without delay, in order to attain a more rapid and cheaper means of transport between the two cities. Opposition to the proposed railway is being offered by the Minister of Railways, but this may possibly be overcome by his withdrawal from the Cabinet. Indeed, the reports furnished by the two State railway engineers who witnessed the high speed trials on the Berlin military railway between Marienfeld and Zossen, have created a favourable impression in Belgium respecting electric traction in general, and have doubtless conduced towards the adoption of a more friendly attitude to the Brussels—Antwerp project. Another witness of the German trials, was M. Empain, a well-known Belgian financier, who was largely interested in the promotion of the Metropolitan Railway in Paris, and whose scheme for an electric railway between the two principal Belgian cities, is believed to be the only one now before the Belgian Government. The length of the railway would be 26 miles, and the capital expenditure is estimated at from £1,600,000 to £2,000,000.

The Austrian electrical companies entertain strong hopes of the introduction of electric traction on the railways at an early date. This is due to the fact that the Minister for Railways is satisfied with the results of the experiments made by the State Railway Administration on certain lines of the Vienna metropolitan railway, and the issue of an order for the adoption of electric locomotion on sections of that railway is, therefore, expected at no distant date. Apart from this scheme, a proposal has been brought forward for the construction of an electric railway between Vienna and Pressburg, but financial difficulties at present stand in the way of the carrying out of the enterprise. The Hungarian Government has just granted the application for a concession for this particular railway, in so far as it will be situated on Hungarian territory, and the building of the line is consequently considered to be assured at some future time. In the case of the proposed electrical equipment of the Arlberg Railway, it is announced that some of the Austrian electrical companies have already responded to the request of the Ministry for Railways, by submitting schemes for the construction of the line, while the other firms will shortly follow their example. The projects will then undergo a thorough examination prior to the Ministry arriving at a decision.

The Italian Meridional Railway Co. has submitted to the Government a plan for the introduction of electric traction on the line located between Milan and Lecco, and the section between Bergamo and Usmata, the combined length of the two being 48 miles. These lines would form an extension of the existing electric railway, which is supplied with three-phase currents at high pressure from an overhead network, and would be worked on the same system. It is estimated that the cost of construction and equipment would amount to £196,000.

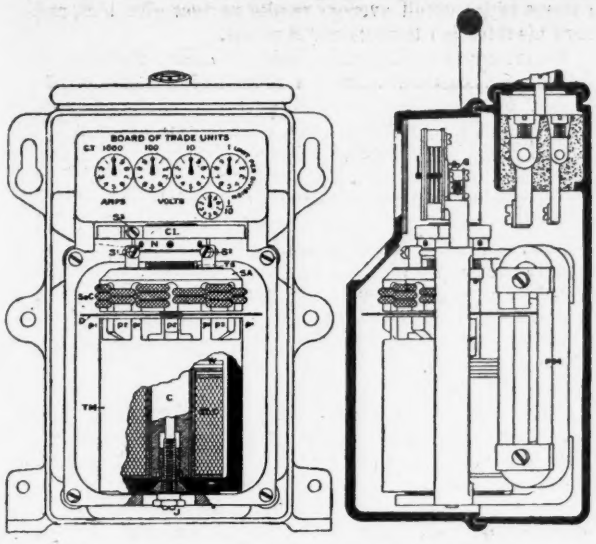
FERRANTI A.C. INTEGRATING WATTMETER.

One of the first reliable and practical ampere-hour meters to appear on the electrical market was the well-known instrument devised by Mr. S. Z. de Ferranti; we now have to announce the advent of a watt-hour meter for alternating currents, which has been developed by Messrs. Ferranti, Ltd., of Hollinwood. This meter is of the induction motor type, and is suitable for use on both inductive and non-inductive circuits; the energy measured is recorded direct in Board of Trade units, and the calibration is easily checked, as the speed of the disc is in all cases the same at full load—namely, 40 r.p.m.

The illustrations given below show the construction and appearance of the meter, of which the following is a description:—

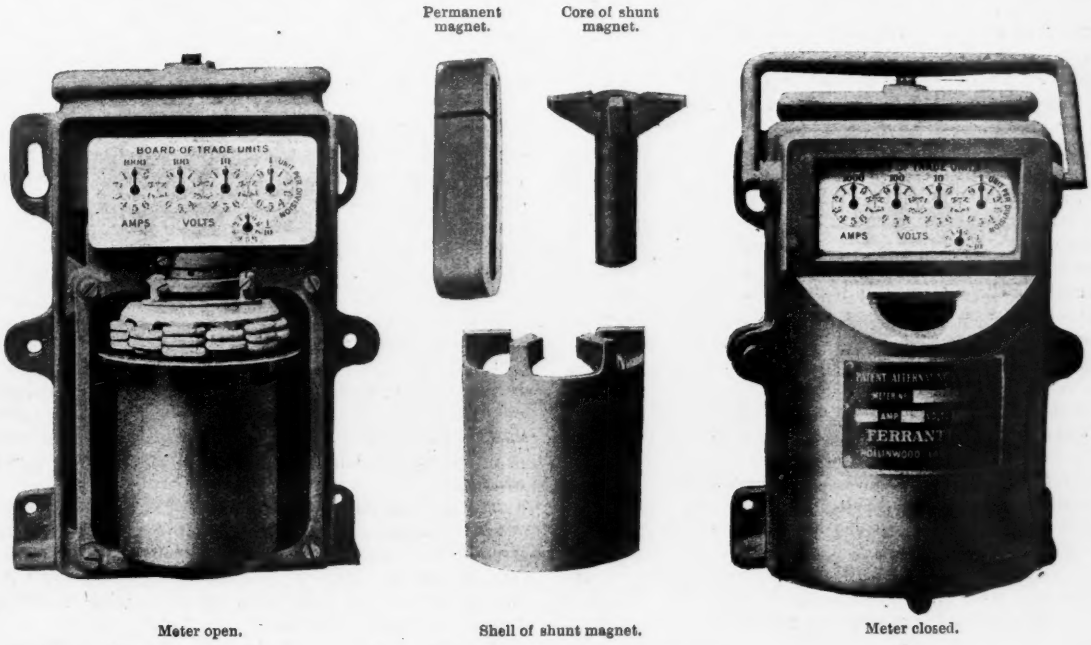
The rotor consists of the aluminium disc D, mounted on a spindle S, which is geared to the recording train of wheels CT, and thus drives the index hands. This disc passes between the poles of two permanent magnets P M, which provide the necessary retarding torque. The shunt circuit

consists of a single shunt coil sh. c, placed round the core c of a special tubular electro-magnet T M; no additional coils are required in this circuit, which in itself possesses the high inductance essential to the working of this type of meter. The core of the magnet is provided with three



Mechanism of Ferranti Integrating Watt-meter.

outward radial poles P2 which alternate with four radial poles P1 projecting inwardly from the shell of the magnet; the combination is placed wholly below the aluminium disc, with the plane of the pole-faces horizontal and parallel to the disc. The series system consists of a slotted armature



Ferranti A.C. Integrating Watt-meter.

s A fixed above the discs, the series coils se c being wound in the slots; this winding is somewhat similar to the well-known wave-winding used by Mr. Ferranti in his alternators in 1884. The slots of the series armature are placed almost directly over the poles of the tubular shunt magnet.

The principle upon which the working of the meter depends is that which is common to all such meters. The shunt circuit being highly inductive, the current therein is practically in quadrature with the impressed E.M.F., and so is the magnetism evoked; the eddy currents induced in the aluminium disc again are in quadrature with the magnetic flux, and therefore attain their maxima simultaneously with the impressed E.M.F. The magnetic field induced by the series winding is in phase with the load current, and acts upon the eddy currents in the disc, producing a driving torque proportional to the product of the impressed potential difference, the main current and the power factor of the consuming apparatus—that is, to the true power supplied to the latter at any moment. The retarding torque due to the permanent magnets is proportional to the speed, and the disc therefore revolves with a speed proportional to the power.

The arrangement of shunt and series windings above described constitutes an important feature of the Ferranti meter, affording as it does a perfect means of adjustment for starting torque without any special coils or poles. If the two magnetic systems were precisely symmetrical both in themselves and in their relative positions, the disc would experience no driving torque whatever when the shunt coil was alone excited, and the frictional error would therefore have an important influence upon the readings at low loads. But by simply rotating the series magnet slightly about the axis of rotation of the disc in either direction, the disc will tend to revolve on the shunt alone in the opposite sense; hence the series magnet is displaced in the direction which gives a slight forward torque when the shunt alone is energised, and by this means the torque due to friction or to any accidental asymmetry of the magnetic circuit can be accurately compensated for. The adjustment is effected by means of two screws, s1 and s2, and the armature is finally fixed by the clamp, C L, in addition to the screws. Owing to this and to the fact that the maximum torque obtainable with the shunt alone is very small, the possibility of "creeping" on the shunt being developed is very remote.

The constant of the meter is adjusted by raising or lowering the series armature by means of the nut N on the threaded spindle, T S, thus strengthening or weakening the action of the coils on the disc; after calibration, the magnet is firmly fixed by the clamp C L and the screw s3.

We are informed that the meter is very accurate on all conditions of circuit, inductive or otherwise, on overloads up to 50 per cent., and on voltages varying 50 per cent. above or below the normal, and that it is practically independent of variations in frequency, wave form and temperature. Every meter is calibrated at the makers' works within the following limits:—1½ per cent. from one-tenth to full load, and 2½ per cent. from one-twentieth to one-tenth load. The accuracy is not affected by short-circuit through a fuse of double the capacity of the meter. A 10-ampere meter starts with ·05 ampere, and can be relied upon to register with a single 250-volt 8-C.P. lamp. In a meter rated at 10 amperes, 200 volts, 100 cycles per second, the shunt losses do not exceed 1·7 watts, and the series loss (at full load) does not exceed 0·8 watts; further, the shunt current is only ·015 ampere, so that not only is the efficiency very

high, but also the wattless current is very small. All meters are tested for insulation with 1,000 volts A.C.

The terminal box is specially arranged to facilitate testing, and a $\frac{1}{10}$th-unit train is provided on the dial with the same object. The mechanical parts are simple and strong, and the enclosure is proof against moisture, insects, &c.; standard sizes have been designed from 3 to 1,000 amperes, of which full particulars can be obtained from the makers. We may add that favourable reports of the performance of the meter have already reached us from independent sources, and we sincerely trust that it will attain as great a vogue as Mr. Ferranti's original ampere-hour meter.

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week.

Steam Turbo-Generating Plant.

Many red herrings have been passed over the trail of this correspondence, and it is difficult to keep on the scent. We will try to get on the line again, but before doing so, must reply to some of the criticisms, so that we may not leave a wrong impression. Mr. Campbell Swinton will find "load factor" defined in the *Electrical Times* tables as—

$$\frac{\text{"Units} \times 100\text{"}}{\text{"Max. load} \times \text{hours."}}$$

We say that even if the units always mean the same thing, such a load factor is of little use in comparing stations under different circumstances. For example:—A Coronation night in Cambridge, or some festive occasion in Scarborough, might seriously increase the usual maximum load, and spoil the load factor for the year.

If, as Mr. Swinton allows, the plant installed was considerably in excess of requirements at both these places at the time, we have no doubt an enterprising station engineer would see his way to do more than he could have done if he had only the allowance of spare plant usual in reciprocating engine stations.

We have drawn all this storm about our ears because we suggested that the excess of plant (since admitted) over the usual maximum requirements might be installed for fear of stripped blades and other difficulties.

We quite agree with Mr. Henry Lea and Mr. Merz that the returns from which the figures have been obtained, do not give all the information required to enable a very exact comparison to be made, and although we made out our list as impartially as possible from the only available statistics, we fail to see that any further discussion of details is in any way useful.

Instead of the lists which have been under discussion, we will adopt Mr. Barker's suggestion, and take from the provincial list given in the *Electrical Times* issue of the 11th inst., the exclusively steam turbine stations—viz., 8, and all the remaining stations—viz., 160. The coal and works costs for the steam turbines run out at ·78d., and 1·6d., as compared with ·738d., and 1·4d., per unit, for the 160 others. Instead of the steam turbines being, as claimed, as good as the best reciprocating engines, the figures for the turbine stations are not even up to the average of the good and bad of all sorts. These figures will, we think, appeal to an open minded reader, as many of the 160 stations have old type and uneconomical plant of various kinds.

Even in the station of the Newcastle Co., which has been referred to by the steam turbine advocates, the published results show that the reciprocating engines supplied by the Wallsend Slipway Co. gave a much better result than the steam turbines under similar conditions of vacuum and superheat.

Mr. Barker is disappointed that we have not accepted his figures in connection with the value he assigned to the inch of vacuum, but we really do not see why we should prefer Mr. Barker's figures to the 4 per cent. per inch in Mr. Wilkinson's paper, or the 6 to 7 per cent. for every inch above 25, as given in a paper on the Curtis turbine, by Mr. W. R. Emmet, published in various electrical papers last October.

There is no doubt that the steam turbine requires for economical running a much better vacuum than would be required for the same economy with the reciprocating engine, and a vacuum that it would be very difficult to obtain in many places.

Mr. Barker has shown great ingenuity in manipulating the tables to prove his point, but we do hope he will be content with the full average results we now give him, and turn his attention to more useful points.

We are afraid he is splitting hairs in raising the point he does concerning the results of a re-trial of a Belliss engine without overhaul after five years' work in a central station. The vacuum was, on the average, about $1\frac{1}{2}$ in. better on the re-trial, and for a compound engine the correction for this would be about 3 per cent., and the consumption at full load would then be 19·79 on the re-trial, against 19·4 on the official trial five years before. But trials were also made at $\frac{3}{4}$, $\frac{1}{2}$, and $\frac{1}{4}$ loads, and taking an average of all the loads, the result, after correcting for vacuum, comes out 20·2 lbs. per B.H.P. after 5½ years, against 20·9 lbs. per B.H.P. originally, or ·7 lbs. better. The engine was put on the test plate exactly as received, without the cylinders being opened out or any adjustments made.

Central station engineers, steam engine manufacturers, and probably consulting engineers, are longing for a chance to use or make steam turbines whenever they feel that they can safely do so without risking their reputation. At present, the problem before them is about as follows:—

The high-speed, self-lubricating, triple-expansion, double-acting reciprocating engine has proved itself capable of doing central station work more comfortably, more economically, and with less risk than any steam turbine yet built, especially when the electric generator attached to it, is taken into account. The steam turbine advocates would like to get the idea abroad that for central station work the steam turbine is overhauling the reciprocating engine, and will soon displace it. How absurd this position is can be easily ascertained by anybody who will take the trouble to find out what is being done. We ourselves, for example, have put through our gates during the 9 months just completed of our present financial year, 56,000 H.P of our engines, say at the rate of 75,000 H.P. per annum, which is a considerable increase on anything we have previously done, and other builders are probably in the same position. Steam turbines, in hand at the present time at least, are a very small item in comparison with the reciprocating engines which are being turned out in this country.

Advocates of steam turbines assert that the reciprocating engine is played out, and has reached its limit, but we know of no such finality. We have made great advances in recent years, and are looking forward to still better results in the near future. On the other hand, the steam turbine position is about as follows:—

1. For more than twenty years it has had the continuous attention of some of the best and most ingenious mechanical engineers in this country or elsewhere, but up to date the chief difficulty—viz., that in connection with the clearance, has not been solved, and is probably incapable of practical solution.

2. The amount of the clearance permitted, to obtain the results published, is so small, that grave practical difficulties are produced by expansion under the temperature of the working steam. Certainly this clearance can never get less during the working period, and we assert that the published figures show that it increases.

3. To enable results to be obtained approaching those we can get from triple-expansion reciprocating engines, superheat of a considerable amount must be employed, and the clearance must be proportionately increased. It is impossible under working conditions in a station to keep the superheat within any but very wide limits, and as the clearance must be made large enough to meet the maximum superheat, waste of steam through the clearance at working temperature must be largely increased.

4. Stripping of blades may be caused by the superheat over-heating them, or over-expanding the rotating part as a whole, and it may also be brought about by water, or a very small foreign substance at this very high peripheral speed.

5. The improvement in economy in the steam turbine is limited by this question of practical clearance, and there does not appear to be much chance of further improvement in view of the great care and thought which has already been expended.

6. The one big point in connection with a steam turbine plant that appeals to everybody, is the fact that the larger sizes especially can be manufactured much more cheaply than the same power of reciprocating plant, but against this must be taken into account the fact that with the steam turbines go boilers and condensing plant much larger than in the case of the reciprocating engine. Any big difference in economy or unreliability of the plant would make the difference in first cost a trivial matter, compared with the trouble which might result from the change.

As the writer will be out of England during the next three or four weeks, he hopes to find on his return that the discussion has been continued on lines useful to your readers.

Belliss & Morcom, Ltd,
ALFRED MORCOM, *Managing Director.*

Birmingham, *December 22nd*, 1903.

Widnes and Runcorn Bridge.

A paragraph appears in your issue with reference to the above work, which has been sent to you without my consent or knowledge, and evidently by the makers of some small article which may possibly be used on the structure. As the information given is absolutely incorrect, which can be seen by referring to the description of the work already published, I shall be glad if you will kindly publish this correction and protest in your next issue.

John J. Webster.

Westminster, S.W., *December 28th*, 1903.

The Shifts of a Shift Engineer.

The "engineers-in-charge" of 9 stations out of 10 do not belong to the town where their station is, and therefore they are compelled to put up with the wily old landlady. It appears to be my lot to meet a bad one, and I am about full up with the misery which I come in contact with in lodgings.

During the last two months I have been in three places, and am going into the fourth next week to try my luck. The cause of my leaving these three places is the same, namely, getting me up too late to have a respectable breakfast and be in time to relieve my colleague who has been running the night shift. The grub also in the lodgings has been very much "off." I could understand the grub being bad if I were paying about 2s. per week, but when it comes to 18s. and £1 per week, I consider we ought to be jolly well looked after.

Could you arrange a list of lodgings where objection to shift work, to breakfast at 7.30 a.m., and to cleanliness does not occur? This could be arranged as follows:—We will call the shift engineer A. A leaves a town to take up a new appointment. In his late place he had jolly fine digs.; could not A send you up the address of the place he was at and you publish the same at a small charge?

I would gladly have a list from time to time, and I know they would be a great help to many a fellow who is going (a perfect stranger) to a new town.

Fair Play to the Lodger.

[While we sympathise with our correspondent's woes, we regret that we cannot undertake the task he suggests; there are several hundred stations in this country, and the list of lodgings would be of portentous dimensions. But in all cases except newly-established undertakings, the best plan would surely be to keep a list of suitable lodgings at the central station for the benefit of "new chums."—EDS. ELEC. REV.]

German Wheels for India.

We wonder who is responsible for the sending of the Indian State Railways' order for 800 pairs of wheels and axles to Germany. The last experience of the Indian Railways, whose order for locomotives went to Germany, was unfavourable. The German makers were proved to be quite unable to work up to the standard of the inspectors. Yet here again the Secretary of State for India sends orders to Germany when the workmen of Sheffield are on half employment! Our Indian Secretary of State did not exhibit himself in an intelligent light on the former occasion, and he appears to have been succeeded by a man of much the same stamp. But did not the present Secretary for India once haunt the rooms of the War Office?

Correspondents.

Production of X Rays.

Can any of your readers give me the benefit of their experience as to the best way of using a 200-volt alternating current for the production of X rays and high frequency currents? If so, I shall be

Grateful.

Walsall Switches.

With further reference to the above, we would point out to the Walsall Electrical Co. that we mentioned in our letter of December 5th that we made a switch of a similar type, but not identically the same, and that the adjustment betwixt the laminated brush contacts was no novelty. As stated in your issue of December 4th, we have been making this adjustment for the past four years.

Richardson & Co.

Manchester, *December 21st*, 1903.

Electric Shocks on Flat-Back Switchboards.

The correspondence appearing under the above heading in your issue of December 18th, 1903, is evidently from the pen of some totally irresponsible person. The accident in question was entirely due to carelessness, and by no means due to faulty design; in fact, had the gear been completely finished, and all division slates, &c., in position, the accident would not have occurred.

The trouble was brought about by one of the erectors attempting to take the dimensions of a *charged* bus-bar fitting with an ordinary fitter's steel rule, and, of course, with the inevitable result—dead short between phases. The injuries the man received were burns, due to his proximity to the arc he had struck between the bars. I might add, for the benefit of "Enquirer," that no switch-gear yet designed is "fool" or "suicide" proof.

Late Outside Superintendent,
Switch Department, Ferranti, Ltd.

Manchester, *December 19th*, 1903.

There is no doubt that the correspondence which has appeared in the ELECTRICAL REVIEW during the past few weeks on the above subject has caused no little amusement to those members of the electrical profession who make switchboard design and manufacture their speciality.

To commence with, Mr. Davids gives an account of the accident which befell a man who happened to accidentally come in contact with some "live" fittings on the switchboard at Parnahyba.

Then "H. W. C." promptly takes the matter up, evidently thinking that he has got a good "bite," and brings his "cellular type," more commonly known as the "Ferranti type," switchboard to the front once more.

There is one thing, amongst others, that "H. W. C." says, which I do not altogether agree with, about "British firms setting themselves steadfastly against switchboards with backs." By this, I suppose, he means high-tension switchboards only, and not low-tension; but this, in my opinion, is incorrect, as there are several "British" electric lighting and power companies at the present time using, and also having made for them, high-tension "flat-back" switchboards.

"H. W. C." evidently gets his notion from the fact that in the olden days when "flat-back" switchboards with chambers at the back were first used for high-tension working, and accidents happened to attendants whilst inspecting or doing repairs, the main thing to do was to design a switchboard which had no chamber or any way round to the back, and on these grounds he advocates the adoption of the "cellular type" switchboard. He also reminds us that in this country switchboards were made with wooden framework; this is quite correct, as everyone

knows who has been inside central stations about eight or nine years ago, perhaps less than that.

The reason for adopting this wooden framework was perhaps that the switchboard (which is invariably and almost always considered to be what one might call the ornament of the station) would have a more pleasing effect to the eye if decorated with wooden moulding.

But one must take into account that the cause of such bad design was not always the fault of the designer or manufacturer; the buyer of the switchboard very often had a say in the matter. Since those days of fires on "switchboards with wooden mouldings," switchboard designers and manufacturers have paid more attention in designing high-tension switchboards to have little or no inflammable material about the boards. Those who have read "H. W. C.'s" article on this subject will certainly think it sounds very strange, where he says *the old metal and "new" wooden framework* (the italics are mine). Surely this particular switchboard was not "made in England," or, at any rate, of British design. Your correspondent "Enquirer" has aptly classified "H. W. C." and Mr. Aimer as ardent supporters of the "cellular type" switchboard, and it is my firm belief that Mr. Aimer has seldom, if ever, seen a "flat-back" high-tension switchboard, to say nothing of being concerned in either design, manufacture or running of the same. He must not run away with the idea that this type of board (a properly designed one) is made similar to a low-tension traction or lighting switchboard, with all the "live" fittings fitted at the back, and exposed so that anyone can easily or accidentally come in contact with them. Nothing of the kind, as I will explain later on.

There is no necessity for me to explain the construction of the "cellular type" of switchboard, as almost every electrical engineer in this country, at any rate, knows its construction. I would like to point out, for the benefit of those who don't know, that nearly every piece of metal inside the "cells" is "alive" when the current is "on" with the exception of, perhaps, instrument cases and the like, and I would also like to inform these ardent supporters, if they are not already aware of the fact, that the current-carrying parts are considerably nearer to the front in the "cellular type" of switchboard (which, of course, means that it is a very easy matter to accidentally come in contact with them), than any designer would ever dream of putting on a well-designed "flat-back" switchboard. Then, again, it is not with the greatest of ease that repairs can be effected on the "cellular type" of switchboard. "H. W. C." and Mr. Aimer seem to dwell so much on the fact that the type of board which they are in favour of has no "back," but they do not tell us of the difficulties which have to be overcome in doing repairs, cleaning, &c.

It sounds all very well when one reads what Mr. Aimer says about simple plugs and links for isolating the different panels, but it is not so easy and pleasant in actual practice for the man who has got the job to do. I wonder if "H. W. C." or Mr. Aimer would even like to find themselves perched on a ladder in front of all this gear, to say nothing of doing any repairs to the same.

It is with "some" consolation that one reads Mr. Aimer's article, where he tells us of the few accidents, none of which were serious, and "H. W. C.'s" article, where he also tells us to what extent the death-roll would have been increased had not the "Ferranti" board been used. But what about the accident which happened to an authorised and competent man at the Midland power station about last spring? The said man accidentally touched some live metal work on one of Messrs. Ferranti's switchboards, whilst removing an instrument, or, at any rate, doing something to the instrument. This accident, I might say, was the means of incapacitating him for many weeks. Then, again, the accident which happened at Leeds about a year ago on one of Messrs. Ferranti's switchboards.

It is very strange that one seldom, if ever, hears of these accidents on the "cellular type" of switchboard; but were they to happen on a "flat-back" switchboard, there is little doubt but that "H. W. C." and Mr. Aimer would very soon make this matter known to the readers of the technical journals.

Now, the majority of accidents which the "flat-back" switchboard has been the cause of were chiefly when this type of board was first used for high tension alternating current working, which at the time led to the adoption of a switchboard without a back, viz., the "cellular type;" but it must be understood that in those days one had not the same experience as at present.

It is quite possible now to design and manufacture a perfectly safe and reliable "flat-back" switchboard for use with extra high pressure, and in a well-designed switchboard of this type there need not be any chance for a man, whether competent or otherwise, to stumble against any of the "live" parts. As for the maze of connections which Mr. Aimer informs us usually exists behind these boards, there is no necessity for this at all. He gives one to understand that the appearance at the back is somewhat after the fashion of the back of a telephone plug board. Perhaps Mr. Aimer is not acquainted with the fact that there are such things in existence as "oil break switches" used for high tension work, the contacts of which are immersed in oil contained in an iron tank, and operated by means of a handle fixed in front of the switchboard, also a host of other things in favour of the "flat-back" switchboard. Then, again, the isolating of any panel can be effected with perhaps greater safety and ease on a "flat-back" switchboard than on one of the "cellular type."

It is true that our central station engineers at home have not adopted the "flat-back" switchboard for high tension work to a very great extent up to the present time, but our Continental friends and our American cousins, who, by the way, are in possession of far greater electrical power transmission schemes than we in England, seem to adopt the "flat-back" switchboard in preference to the "cellular type."

The subject of high tension switchboard design is one which, I think, ought to have more attention paid to it, and I venture to say that the majority of correspondence on this subject which appears in the technical papers is done more from a business standpoint than technical.

Fredk. Walton, A.I.E.E.

Loughborough, *December, 23rd*, 1903.

I notice that I am called upon by an "amused" "Enquirer" to give an explanation of the accident which happened at Leeds 12 months ago, and I have much pleasure in doing so.

In the first place, however, let me put my friend right as to what constitutes the subject under discussion. It is not, as he mentions, the supposed identity of any of your "mysterious" correspondents. Nor is it the question of the *absolute* security of any particular type of switchgear. It matters not to what state of excellence we attain in the design of switchgear, we cannot altogether dispose of the human element, and if a man deliberately places his head in the switch panel, his injuries can scarcely be credited to the design of the board. This is not quite what happened at Leeds, but in substance and effect it is not very far removed from it.

As a matter of fact, the short-circuiting of the bus-bars was the outcome of a man essaying to *measure up the live bars with a steel rule*. I am not sure what became of the rule, but it was, as "Enquirer" states, only by the merest miracle that the man escaped with his life. In justice to the man, I will explain that he did not deliberately clap the rule on to the bus-bars, but that he was holding it sufficiently near to get the required particulars, when something distracted his attention for a moment, and caused him to jerk the rule against the bars. This, of course, does not excuse the man's foolhardiness in doing what he did.

This accident was simply the outcome of one of these extraordinary and incomprehensible lapses of the intelligence which is a feature of the ineradicable human element which occasionally asserts itself, and, further, although it occurred on a Ferranti board, it does not in the least detract from the record which I attributed to the cellular switchboards of that firm's make. If "Enquirer" will look at my letter a little more carefully, he will find that what I said was that I believed it was a fact that no accident worth mentioning had yet occurred *in connection with the working of these boards*.

This accident forms, moreover, a practical demonstration of one of the points of superiority of the cellular backless type. Had this man been measuring up the bars on a flat-

back board, he would in all probability have had to go round to the back of the board, and if he had touched the bars with his rule, as at Leeds, the shock would probably have caused him to fall against many of the other live parts at the back, instead of falling clear away from all live connections as on the cellular backless board at Leeds. Then again, even supposing he managed to fall clear of the "maze of connections," there would be the chance (assuming that no main fuses blew, or that there were any other outward signs of what had taken place) of his lying insensible at the back of the board for some considerable time before being discovered. This delay in commencing artificial respiration or otherwise taking steps towards resuscitation might, and very probably would, mean a matter of life or death to the man; whereas on the cellular backless type, where the man would fall in full view of the station attendants, the chance of such delay is reduced to a minimum.

In conclusion, I beg to point out to "Enquirer" that I did not claim absolute security for any type of board; I merely tried to show that for H.T. switchgear, in the matter of safety, the cellular backless board is infinitely superior to the flat-back board, and reduces to a minimum the chances of disaster which are liable to arise through accidental contact with live parts, as a typical example of which the affair at Parnahyba (which opened this discussion) may be quoted. As evidence of this fact, it may be mentioned that at least 20 flat-back boards in important central stations in this country have been replaced by cellular backless boards.

Further, although the human element, such as was displayed at Leeds, cannot be completely disposed of in *any* type, still I submit that it is abundantly clear that the balance of immunity in this respect also is very much in favour of the cellular backless type.

P. B. Aimer.

Manchester, *December 19th*, 1903.

Notes on Engine Driving in Electric Light Stations.

Upon reading the above notes last week I was struck with the want of practical knowledge displayed by the writer of the article. To take a few of his points:—

1. The appalling amount of oil which is lost through the glands of engines without distance pieces. Modern engines are all fitted either with distance pieces or an equivalent method of prevention of waste of oil.

2. Drivers should see that the water is pumped from the crank chamber every night. It is usual to place a tap at the bottom of the crank pit to run off the water after it has settled down.

3. Where lubrication is effected by oil boxes and trimmings, the first thing to do after the engine is shut down is to remove the trimmings to prevent waste of oil. Is the writer of this article writing of 10-KW. sets, or modern central station plant? If the latter, I should like to know the builder of modern engines who lubricates his bearings with lamp-wick trimmings.

4. If the H.P. and L.P. drains discharge into the same pipe. No engineer with common sense would connect his H.P. and L.P. drains together; and the remedy suggested, viz., to throttle the H.P. drains, is quite worthy of the writer.

5. On shutting down, with jet condensers, care should be taken lest the vacuum lift the water into the cylinder. I should advise the writer of the article to make the following little experiment:—Get a glass tube and fit a plunger into it, so as to practically make it air tight, then fill the tube a quarter full of water, and close up one end, then partly withdraw the plunger to make a vacuum, and see how much water he will lift up the tube. He will then find that to lift water into the cylinder of an engine by means of vacuum alone is impossible.

6. On opening the doors of enclosed engines for inspection, the columns will be found full of oil vapour. A naked light should never be placed inside until this vapour has dispersed, as, with air, it forms a very explosive mixture. Does the writer of the article run his engines with a low-flash paraffin oil, or ordinary engine oil, and if the latter, when, and where, did he either hear or know of an explosion caused by this?

7. The writer has known of many hot top and bottom ends, meaning crosshead and crank-pin bearings, caused through nothing but leaky piston glands.

Crank-pins are not usually oiled through oil cups without covers, into which the water could drop and wash out the oil; the usual method of oiling is through a banjo pipe, and no engineer would accept leaky glands as an excuse for a hot crank-pin.

In conclusion, I should advise your correspondent to go and get a few years' practical experience of engine building and running of same, after which, if he should write another article, he will not be so liable to make the above mistakes.

A. Kay.

Manchester.

Telephone Facilities in London.

The newspapers are very fond of holding up London to ridicule as a place hopelessly behind the times, on the ground that in the largest city of the world fewer telephonic instruments have been installed in proportion to the population than is the case in any other towns where similar facilities for inter-communication exist. The fact as to the relative number of private wires is, I presume, correct; but it is important to realise that the blame for this state of affairs does not attach itself wholly to the public. For example, some months ago I was desirous of having the "benefit of the service," to use the conventional phrase, at my private house, which is well within the county. On applying to the Post Office, I was informed that the system had not reached my neighbourhood, although so many exchanges were working elsewhere—a piece of news more interesting than relevant. I then approached the National Co., and was promised a connection within five or six weeks, subject to the usual proviso, which may mean anything or nothing. After waiting eight weeks, during which time I am favoured with a copy of a highly ambitious map showing the ramifications of the London telephone system, with its tentacles extending to the parts beyond Jordan, and after carefully watching the posts that are close to my place, I finally receive a letter "regretting that we are unable to give you a date for the completion of your line."

North Londoner.

P.S.—If I give my age, and submit myself to medical examination, do you think anybody at Lloyd's or elsewhere will insure me against dying of old age without benefit of service?

Superheated Steam.

Referring to your notice of Mr. Reynolds's paper on the use of superheated steam, you refer to the firing of superheater furnaces; and point out that, while furnace temperature should be not less than 2,500° F., the gases should reach superheater tubes at only half this temperature.

It is very easy to do this with Erith's underfeed stoker, where we generally obtain 14 per cent. CO_2, corresponding to a furnace temperature as high as 3,500° F.; but while thus burning exactly as much fuel as required, in the most efficient manner, we admit cold air at the rear of the bridge wall, viz., after combustion is completed, and temper this heat down to any desired degree, without in any way wasting fuel.

We have pursued this practice for many years past on our drying machines; where, with a furnace temperature over 3,000° F., ensuring smokeless and economical combustion of cheap slack coal on our stoker, we have often reduced the temperature in the chamber behind the bridge wall as low even as 300° F.

For superheaters the identical method is adopted, and it is very easy to maintain 1,250° or any other temperature at the tubes, while having 3,500° in the furnace proper, and still using very little space.

It would, of course, be bad practice to reduce the furnace temperature, and so spoil combustion, by passing surplus air through the fire.

Erith's Engineering Co.
CHARLES ERITH, *Manager.*

London, E.C., *December 23rd*, 1903.

Variable Speed Continuous-current Motors.

I have noticed the correspondence in your recent numbers, under the above heading, with much interest. I do not

pretend to know all about printing machines, but I have had a good deal of experience with the equipping of them with electric motors. Instead of giving my opinion, I feel sure a few facts in my experience will be interesting, in addition to the views of your correspondents on the subject. I have had to deal in detail with the individual equipping of nearly 2,000 flat bed letterpress and litho. machines, the former varying chiefly between 1 and 5-H.P., and the majority of machines varying in size from double-crown to quad-royal.

I have gone to the trouble of tabulating the speed specified in connection with the above machines for use in the factories of most of our leading printers in this country. I find on the average the maximum speed is about 54 per cent. above the minimum. The machines are mostly English made, by the celebrated Otley firms, and the following are the average speed ranges on machines as found in everyday use. The extracts have been made from several hundred machines :—

Maker	(*a*)	820—1,340	impressions per hour.
"	(*b*)	730—1,110	" " "
"	(*c*)	1,110—1,570	" " "
"	(*d*)	1,110—1,610	" " "
"	(*e*)	810—1,311	" " "
"	(*f*)	800—1,300	" " "
"	(*g*)	860—1,390	" " "
"	(*h*)	780—1,170	" " "
"	(*i*)	920—1,390	" " "

Only about 1 per cent. of the aforementioned 2,000 machines were specified, " no speed regulation." In several cases the range has been 500—1,400 impressions per hour. This has chiefly been with small printers having a varied class of work and only a few machines, the low speed of 500 impressions being for fine art heavy black work. It is quite true that in some cases, printers going in for electrical driving ask for a greater speed range than they had before ; but the disadvantage of specifying a higher speed than they will actually require in practice is always pointed out, for economical reasons. At the same time, it should be borne in mind that with a direct connected positively driving motor a higher speed and, consequently, more output in a given time, can be obtained than with a belt drive, with certain classes of work, due to the steadier running and better register. The testimony of printers on this subject is, undoubtedly, welcome, and valuable to the electrical engineer. I have found authorities differ, even in the printing trade !

W. A. Clatworthy.

Newcastle-on-Tyne, *December 21st*, 1903.

Design of Continuous-Current Variable-Speed Motors.

Letters from Messrs. Dodd and Hird, in your issues of the 11th and 18th Dec. respectively, with reference to my article in the Electrical Review of the 4th Dec., entitled " Speed Variation of Continuous Current Motors by Shunt Control," require comment. Mr. Dodd's remarks are applicable exclusively to motors designed on the basis of relying upon the magnetic fringe for reversing the current on the short-circuited coil. For motors designed on those lines he is quite right in asserting that factors other than the reactance voltage, and notably the distortion, affect the commutation. But motors designed on those lines should not be used where speed variation by shunt control is required. For such work, motors operating with the brushes in the geometrical neutral point should be employed, and Mr. Dodd will admit that for such motors the magnitude of the reactance voltage *and mechanical considerations* constitute the determining factor as regards commutation. I endeavoured to make clear that, the lower the speed, the more nearly may such motors conform to the cheapest design, as determined from thermal considerations. Mr. Dodd will recognise the truth of this when he remembers that in the cases where he has designed very low-speed motors for special purposes, the magnitude of the reactance voltage with only moderate commutator sub-division has been so low as not to influence the choice of proportions, and thus has permitted him to proportion his motor for minimum cost, the thermal considerations, or considerations of regulation or efficiency, alone requiring to be taken into account. In very high-speed motors, on the contrary, no practicable amount of commutator sub-division suffices to bring the reactance voltage within desirable limits, and proportions entailing expensive construction, and for other reasons than those imposed by thermal considerations, have to be employed.

Mr. Hird must admit that I have not deserved the charge of asserting that " the limit of output of small motors depends on the sparking point only," when he remembers that the chief purpose of my article was to show the incorrectness of the prevailing notion that motors for variable speed by shunt control must, in order to be practicable from the commutating standpoint, be several times larger than motors for constant speed work at the lowest speed required of the variable speed motor. This erroneous but widely-spread view was based upon the belief that otherwise there must be poor commutation at the higher speeds, a belief which it was the object of my article to dispel.

I have in my article endeavoured to show when commutation would, and when it would not, impose limitations ; and I have shown that the lower the speed, the more closely may the design approach the cheapest design from the thermal standpoint, and that below certain speed limits which I endeavoured to roughly define, the limitations relate solely to thermal considerations, and occasionally to considerations of regulation and efficiency.

This certainly is a very different assertion than that of which Mr. Hird accuses me.

Mr. Hird dreads the increased expenses to manufacturers which he states will attend the general adoption of the " geometrical neutral point " for the fixed brush position. I have shown in my article that for motors below certain speeds there will be no increased expense, and have stated that I consider it good engineering to encourage the use of any type of machine under the conditions for which it is inherently best adapted.

In the cases where continuous current motors must be used at speeds where, in spite of the best design, the commutation requirements necessitate electro-magnetic reversal of the current in the short-circuited coil, there is, of course, no longer any question of the " geometrical neutral point." But, wherever possible, lower speeds should be employed, and I note that Mr. Hird appears to be in agreement with me that the cost of commutating machinery increases but very slowly with decreased speed.

H. M. Hobart.

London, *December 29th*, 1903.

[Will " E. M. F.," who has written to us on the " Maximum Demand System," kindly send his name and address ? Our correspondents frequently forget that they must send both name and address as evidence of good faith, before we can publish their communications.—Eds. E.R.]

[Information Wanted.—We have received a further inquiry for the address of the makers of Dr. Timm's patent electric furnace for assay work, and for particulars of the same.—Eds. E.R.]

REVIEW.

The Elements of Electrical Engineering. By Tyson Sewell, A.I.E.E. London : Crosby Lockwood & Son. 1903. Price 7s. 6d.

This volume is intended to cover the whole ground of a first year's electrical engineering course, and is based upon courses of lectures given by the author. Starting first with Ohm's law, the author follows with chapters on units and circuits. These are very clearly and intelligently written, and it is apparent that the author has a better grasp of this portion of the subject than is usually to be found in kindred books.

Problems bearing upon the general principles involved are carefully worked out in detail in the various chapters. We suggest that on p. 39, in working out the " volt drop per yard " of a pair of cables at a given current density, the expression " per yard run," or " per yard distance " should be used instead of " per yard " only.

In the everyday work of estimating the mistake frequently occurs of quoting for a yard of cable instead of for two yards, owing to the use of an indefinite or ambiguous expression.

In the three succeeding chapters the heating, magnetic, and chemical properties of the electric current are dealt with. In the first named, the difference between heat and temperature is thoughtfully explained, and, generally speaking, correctly. There are, however, one or two little slips that have been overlooked.

One occurs on p. 50. After explaining that a red-hot pin contains less heat than a kettle of boiling water, the author says: "The reason why the pin has attained such a high temperature with so small a quantity of heat is that it contains a very small amount of material. Had the pin been twice as thick or twice as long, it would have required twice the quantity of heat to raise it to a red heat." "Twice as thick" should read "of twice the section."

In the chapter on "The Magnetisation of Iron," all the magnetic calculations for the field magnets of a two-pole upright dynamo are worked out, including the densities in the various parts of the magnet and air-gaps, and also the ampere-turns required for each part of the circuit, and in a later portion of the book the continuous-current dynamo is discussed at length. In fig. 139, p. 260, an armature core with a hexagonal hole for the shaft is shown. Such an armature might be found in a museum of antiquities. The type of end connections, too, is somewhat antiquated.

The author would have done well to stick to general principles in this volume, leaving out all details of manufacture; the small amount of such information given is apt to be rather misleading than otherwise, and in endeavouring to compress a great deal into a minimum of space, both grammar and composition are occasionally sacrificed. Thus, for example: "The outer circumference of the stampings are now commonly made with a large number of slots." And again: "Now the more conductors we get on the armature, the smaller become the other factors which determine the E.M.F., and, therefore, the tendency is to make the number as large as possible from considerations of the maximum-allowable heating and armature reaction, and though in the case of mains (where the chief consideration is that of voltage drop), we allow a current density of 1,000 amperes per sq. in., we find the current density in most dynamo armatures varying between 1,800 to 2,500 amperes per sq. in., depending on the maximum allowable temperature rise at full load, which again depends on C^2R." Not a very elegant sentence, even if accurate.

The Admiralty temperature rise is given as "30° F. one minute from the time the machine has been stopped," whereas this should be "within one minute of stopping"—a very different thing. The final rise allowed is 70° F., not 30° F., a fact of which the author does not appear to be aware.

The characteristic curve of a shunt dynamo (fig. 163) is a little out of date, and has been copied and re-copied from the oldest text-books on dynamos.

The last chapter is on "Direct-Current Motors," and, whilst fairly accurate, is not quite free from faults. On p. 311 it is sought to prove that, by weakening the field 10 per cent., the torque of a shunt-wound motor is increased by 46 per cent. The reasoning is somewhat curious. The motor armature is assumed to have an efficiency of 85 per cent., and to work at 500 volts. The author makes the back E.M.F. 15 per cent. less than the impressed E.M.F., thus assuming all the losses in the armature to be C^2R losses. This assumption occurs in other parts of the same chapter.

"Now, suppose we reduce N by 10 per cent., then we also reduce the back E.M.F. by 10 per cent., making it = 382·5 volts.

"Now, the current in the first case—

$$= \frac{E - e}{R} = \frac{500 - 425}{R} = \frac{75}{R},$$

and the current in the second case

$$\frac{E - e}{R} = \frac{500 - 382{\cdot}5}{R} = \frac{117{\cdot}5}{R},$$

which is an increase of 56 per cent. Therefore, at the same speed, by weakening the field 10 per cent., we get an increase in the torque of 56 per cent. due to the current in the armature, minus 10 per cent. due to the decrease in the field strength, or a total increase in the torque of 46 per cent."

This is, of course, perfectly absurd, and the error is due to the author assuming the motor to run at a constant speed with a variable field. The extraordinary thing is, that he is discussing speed control by variation of the shunt resistance; but having got it into his head that the torque is increased as the field is weakened, he forgets for the moment that the speed has increased, making the back E.M.F. practically the same as before. For the same power exerted, the torque is, of course, less, not greater, at the increased speed. The same error is repeated on the last page of the book.

The author discusses at some length the disadvantages of compound-wound motors, apparently unaware that in compound-wound motors, so-called, the series coils assist, not oppose, the shunt. Such a winding possesses considerable advantages for many purposes.

Arc and incandescent lamps, accumulators and measuring instruments are dealt with, and apart from the last two chapters, where the author ventures a little beyond his depth, the book is one that can be recommended.

[It is interesting to note that since the above was written a 2nd edition has been issued, to which we shall refer later.—Eds. E.R.]

FIRE AT BRISTOL ELECTRICITY WORKS.

We have received the following official communication from Mr. H. Faraday Proctor, city electrical engineer, to whom we are also indebted for the accompanying photographs:—

A fire occurred at the Temple Back Electricity Works, belonging to the Corporation of Bristol, on Wednesday evening (Dec. 23rd) at 5.15 p.m., resulting in the total destruction of the 2,000-volt high tension "Ferranti" switchgear, and other damage, including the roof and windows of the engine room. The exact spot at which the trouble commenced and the cause of the same cannot at present be ascertained. The machine switchboard, wattmeter switchboard, trunk feeders from the Avonbank electricity works, and the whole of the 44 feeder panels were totally destroyed, as well as all the cables leading up to them from underground. Steps were immediately taken to shut off all current and shut down the boilers. The Fire Brigade were quickly on the scene, and the fire was soon got under control. The whole of the staff and employés immediately turned their attention to getting lighting on the premises to facilitate the carrying out of temporary work which was necessary. The Bristol Tramways and Carriage Co., Ltd., kindly volunteered to start up their St. George's station, which had been out of use for some considerable time, and also to run cables and supplement the continuous current supply if necessary. The Corporation availed themselves of the offer to the extent of some temporary arc lighting in the engine room, and the Tramway Co. supplied, erected and connected five arc lamps in the engine room, running cables from their Counterslip power station close at hand. By the time this work was done, however, the continuous current supply of the Corporation was again in operation, the whole of the continuous current power consumers having energy available at 2.30 a.m. on Thursday morning, thus enabling the different newspapers, all of whom use electricity for printing purposes, to get out their early editions.

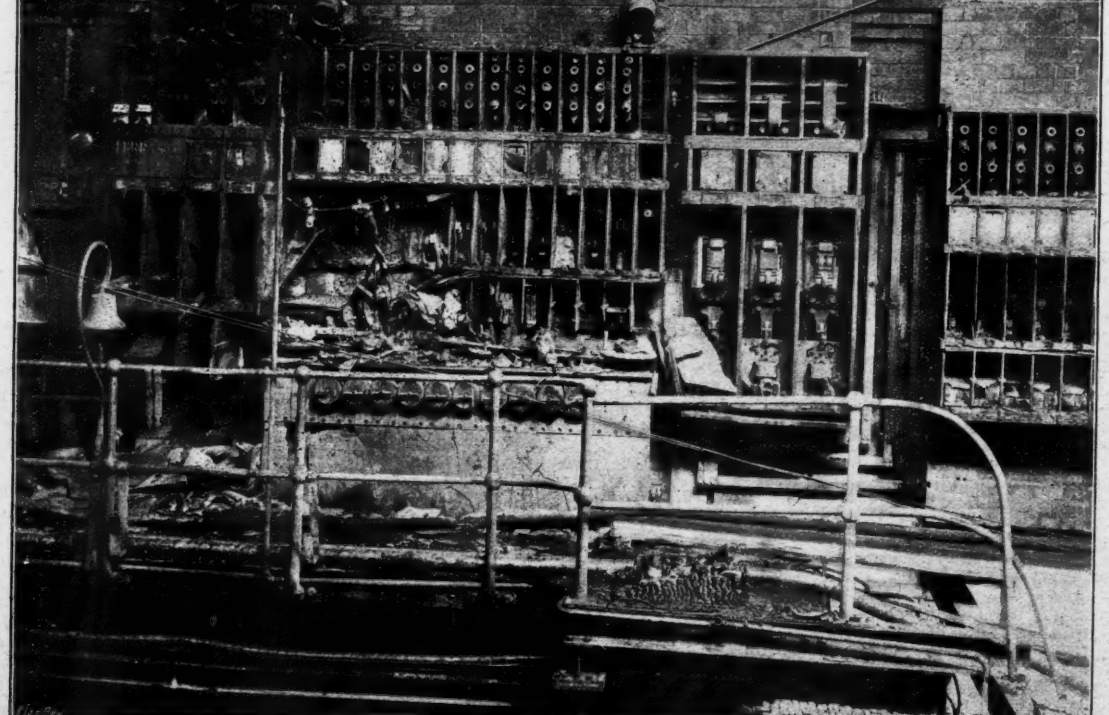
Trunk cables from the Avonbank electricity works were joined across to the Clifton and Redland feeders outside the works, thus enabling the alternating-current supply in these districts to be started up at about the same hour. The new 5-ampere arc lamps (365 in number) for lighting public thoroughfares in different districts being supplied from feeder pillars at different parts of the city from the continuous-current supply system, were in operation at about 2.30 a.m. on Thursday morning also. Many other arc lighting circuits were able to be started up shortly afterwards, the continuous-current switchboards and machinery being damaged to a much lesser extent than was the case with the high-tension gear. Line resistances and other controlling gear, being in a very wet condition from the liberal application of the hose

pipe, of course caused some trouble, but the bulk of the lighting was kept going after the hour above mentioned. A temporary distributing switchboard was at once put in hand, and to this were joined the trunk feeders from the Avonbank electricity works, and the whole of the distributing feeders connecting the 60 or 70 sub-stations with the Temple Back works were joined up to this, joints having been made on all these cables in the street outside the works. This being done, all the feeders which were in proper condition were started up, the Clifton and Redland districts being switched off for this purpose, so that all might be put on together. The whole of the supply, both alternating and continuous, was in full working order by about 8 p.m. on Thursday evening.

Numberless telegrams and other messages offering assistance, and expressing sympathy, were received from all parts of the kingdom. These have been too numerous to reply to during the extreme pressure of work, but gratitude is felt towards all those who thus expressed their feelings, and equally so to those who have only refrained from doing so in case they should take up the time of those engaged in rectifying the troubles.

The engine-room roof and windows, which were burnt out, were protected as early as possible, the whole roof being covered with tarpaulins, and the windows boarded up. Fortunately, there has been little wet weather since the accident, and this has greatly assisted in the work that has been necessary.

Some of the Effects of the Fire at Temple Back, Bristol.



The A.C. Switchboard at Temple Back after the Fire.

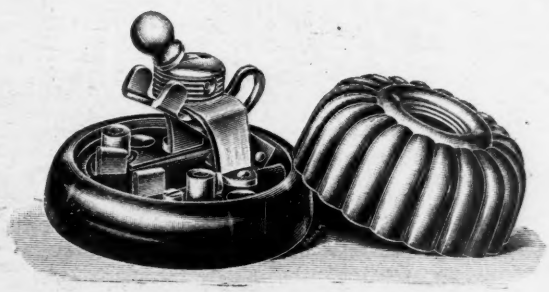
The whole of the staff and employés were kept hard at it during Wednesday night and until midnight on Thursday; and, in addition to those at present engaged in the works, some former assistants have most kindly come down to render assistance which, owing to their knowledge of the

details in the station, has proved most valuable. For tunately, some of the machines at the Temple Back works were left in such a condition that, in spite of the great volume of water that was poured upon them, they were able to be started up after being dried out by passing current through them. The boiler house and steam plant is all, so far as can be ascertained, in working order, none of such plant so far having given any trouble. The difficulty to be coped with now is the finding of a switchboard which will really be reliable under similar conditions on a supply system of 2,000 volts alternating.

Up to Saturday no meeting of the Electrical Committee was summoned, as Alderman George Pearson, the chairman, expressed the view that it was better to give the officials an absolutely free hand to deal with matters, rather than to take up their time by holding committee meetings, or by restricting their efforts in any other direction. This, of course, has greatly facilitated the expeditious restoration of the supply.

BUSINESS NOTES.

G.E.C. New Tumbler Switch.—The General Electric Co, Ltd., of Queen Victoria Street, E.C., have designed an improved form of tumbler switch, which they are now putting on the market. The special feature about the switch is the increased length of break. When in the "off" position, the two contact pieces have a break of practically ½ in., and owing to the spring being right at the back of the bridge instead of in the middle, as is usual in this class of switch, both these contacts have practically the same clearance from every other metal piece in the switch mechanism. The link motion is on the bottom side of handle, which is of the General Electric Co.'s lever type with the addition of a link underneath. This link is so arranged that it gives to the tongue piece



NEW TUMBLER SWITCH.

positive action when switching off. The mechanical construction of the new switch is claimed to be simple yet reliable, and it has a very smooth action. Special precaution has been taken against breakage of the tongue piece, which in the older types is made up of brass-bound fibre. The tongue piece is now of one solid metal stamping, and thus a difficulty often experienced with former patterns is successfully got rid of. Another improvement which is adopted in all the newer forms of tumbler switches is the provision of conical holes in the base through which to thread the insulated leads. The switch is mounted on the usual black or white China base, and the cover is of the fluted brass pattern.

Concert.—The annual Christmas concert given by the employés of the Robertson Electric Lamp Works took place on Saturday, December 19th, in the dining hall of the factory. A company of over 800 assembled, and the concert was a great success in every way. The chair was taken by the manager, Mr. Wilson, and several of the directors, including the chairman, Mr. Hirst, were present.

American Electrical Exports.—The value of the electrical appliances, including telephone and telegraph instruments, exported from the United States during October last amounted to £86,164 as compared with only £74,634 in the corresponding month of 1902. The total for the first ten months of 1903 is returned at £800,372, an increase of £110,916, as compared with the corresponding period of 1902. Turning now to the exports of American electrical machinery, these show a marked decline. For October last they only amounted to £82,691, contrasting with £135,524 in the same month a year ago, while for the ten months ending with October a total of only £857,710 is shown, this being a decline of no less than £157,644 as compared with the first ten months of 1902.

Bradford.—The Bradford Electrical Engineering Co. has secured the contract for the electric lighting installation of the Presbyterian Church and Schools.

Electrical Wares Exported.

WEEK ENDING DEC. 23RD, 1902.

	Value £18
Adelaide	
Alexandria	21
Beira	447
Bombay	225
Buenos Ayres	525
Calcutta	40
Cape Town	29
,, Teleg. mat.	70
Channel Islands	21
Christiania. Teleg. wire	87
Colombo	64
Delagoa Bay	10
Durban	659
,, Teleg. mat.	3,250
,, Teleg. plant	2,107
East London	1,403
Flushing	25
Gibraltar	73
Halifax	22
Hobart	915
Hong Kong	16
Kure. Ships' telegraph	140
Launceston	17
Lisbon	180
,, Teleg. mat.	50
Madras	16
Mauritius. Teleg. mat.	72
Melbourne	177
Mombassa	75
Montreal	36
Nagasaki	81
New York	79
Ostend	62
Perth	105
Port Elizabeth	283
Rio de Janeiro	5
Rotterdam. Teleg. wire	56
Shanghai	792
Stockholm. Teleg. wire	174
Sydney	767
Trinidad	94
Wellington. Teleg. wire	3,782
,, Teleph. mat.	925
Zanzibar	45
Total	£17,835

WEEK ENDING DEC. 22ND, 1903

	Value £205
Adelaide	
Alexandria	238
Amsterdam	285
Antwerp. Elec. fuses	235
Auckland	355
Bangkok	50
Batavia	35
Bombay. Teleg. mat.	231
Calcutta	571
Cape Town	17
Chemulpo	69
Colombo	45
Durban	1,019
East London	197
Gibraltar	52
,, Elec. cable	1,219
,, Teleg. mat.	53
Grenada. Teleg. mat.	16
Halifax. Elec. detonators	23
Hobart. Teleph. cable	685
Jersey and Guernsey	70
Malta	55
Melbourne	152
Nagasaki. Elec. lighting cable	240
Otago	72
Perth. Elec cable	1,490
,,	194
Port Elizabeth	421
Rio Janeiro	163
Rosario. Teleg. mat.	172
Shanghai	162
Singapore	54
Sydney	484
Wellington	40
,, Telephones	1,263
Yokohama	151
,, Teleg cable	1,089
Total	£11,503

Foreign Goods Transhipped.

	Value £18
Calcutta. Elec. apprts	
Halifax. Elec. mat.	64
Melbourne. Teleph. goods	87
Total	£169

	Value £63
Durban. Elec. lamps	
,, Elec. manfs.	61
Tientsin. Elec. mat.	37
Total	£161

Electrical Wares Exported.

WEEK ENDING DEC. 30TH, 1902.

	Value £40
Amsterdam	
Bombay. Teleg. mat.	323
Bordeaux	23
Calcutta	2,671
Cape Town	480
,, Teleg. mat.	1,705
Colombo	22
Durban	13
Fremantle	975
Madras	22
Melbourne	18
Nagasaki	18
Osaka	359
Penang. Elec. light cables	175
Perth	1,118
Port Elizabeth	172
Rio de Janeiro	21
Singapore. Teleg. cable	32,670
Sydney	134
Total	£40,959

WEEK ENDING DEC. 29TH, 1903.

	Value £60
Adelaide	
Amsterdam	122
Bremen	65
Calcutta	304
Cape Town	382
Colombo	68
Delagoa Bay. Teleg. mat.	643
,, 205 tons teleg. poles	—
Durban	1,802
,, Teleg. plant	3,273
East London	180
Fremantle	148
Hong Kong	85
Maceio	49
North Atlantic. Teleg. cable	2,500
Penang	52
Perth	230
Port Elizabeth	151
Rio Janeiro	78
Rouen	740
St. John's, N.B.	121
Shanghai	56
Sydney	61
,, Elec. light cable	2,020
Trieste	15
Total	£13,210

Foreign Goods Transhipped.

	Value £158
Bremen. Elec. machinery.	
Lisbon. Elec. apparatus	45
Total	£203

Annual Dinners and Suppers. — The first annual dinner of the TEESIDE AND DISTRICT ELECTRICAL CONTRACTORS' ASSOCIATION was held at West Hartlepool on Dec. 21st, Mr. Watson, of Stockton, presiding. Mr. J. Spence (Newcastle) submitted the toast of the "Teeside Electrical Contractors' Association," stating that the object of that Association was to band themselves together to push forward electrical work of all classes, and to prevent that class of work called "jerry wiring." He wished the Association every success, and assured them that the manufacturers would always try to work harmoniously with them. Mr. Watson, in his reply, said that although the Association had not yet been quite a year in existence, it had as members half the electrical contractors in the district. It had done good work since it was organised, and they were anxious to get all the firms in, in order to strengthen their hands. They had been assisted very greatly by the corporations and manufacturers, and the National Association had recently signed certain agreements which would greatly benefit the trade in the future. Mr. Tattersall (Middlesbrough) also responded. Mr. G. H. Prescott (West Hartlepool) treasurer of the Association, proposed the toast of "The Visitors," and, in reply to Councillor Boanson, assured him that the object of the Association was not to run up prices nor to fight the workmen, but to further the cause of the electrical industry, and to ensure the turning out of better work. Mr. Friedericha, the Corporation electrical engineer, who replied, commended the contractors for

combining to prevent a lot of bad work, which he had noticed had been going on, not in that town, but in other towns where he had been. He also supported Mr. Boanson's remarks with regard to the education of apprentices and men. If they did that they would be helping along the industry perhaps more than they thought.

The first annual dinner of the Manchester branch of Messrs. Drake & Gorham, Ltd., was held at the Clarence Hotel on Wednesday last week, when about 60 of the staff, including a few guests, sat down. Mr. George Hamilton, the manager of the Manchester office, presided, and Mr. J. S. Foreman was in the vice-chair. Letters of regret from the directors of the company and others were read. Mr. H. W. Scutts, assistant manager in Manchester, gave the toast "Drake & Gorham, Ltd.," and Mr. Hamilton, in responding for the company, reviewed the work of the past two years, complimenting the foremen and staff on the great progress made. He stated that over 25,000 incandescent lamps, many motors, generators and arc lamps, had been installed during that period. The toast of "The Guests" was given by Mr. T. F. Allden. Mr. C. B. Handyside replied. The rest of the evening was given up to music. Mr. H. Dodsworth, one of the chief members of the outdoor staff, proposed a vote of thanks to the chairman, and the evening was brought to a close with a special vote of thanks to Mr. Foreman for organising the dinner, and to other members of the staff who had supported him.

The second annual supper and smoking concert of the staff of Messrs. R. G. Nicholson & Co., electrical engineers, of Manchester, was held recently at the Atlantic Restaurant, Cross Street, Manchester. Mr. R. G. Nicholson presided, and there was a large attendance. The usual loyal toasts were proposed from the chair, and duly honoured. Mr. C. H. Montgomery proposed "Success to the Firm of Messrs. R. G. Nicholson & Co." Mr. R. G. Nicholson responded.

Catalogues and Calendars.—The *Chemical Trade Journal* has issued its calendar for 1904.

The Forest City Electric Co., of Manchester, is circulating a leaflet showing illustrations of rail joints at Bury, Salford, Durban, Newcastle and Huddersfield, which have been bonded with "Protected" rail bonds.

From Messrs. Kelvin & James White, Ltd., of Glasgow, we have received several illustrated lists describing the Kelvin combined S.R. ammeter and voltmeter, the Kelvin rail-bond testing set, and the Workshop Wheatstone bridge.

Messrs. W. T. Glover & Co., Ltd., of Trafford Park, following the excellent course adopted by them last year, have just issued a wall calendar for 1904 with contents which appeal directly to the mind of the electrical engineer. Every day in the year has its slip, and every slip has either its clipping from the remarks made by known electrical engineers in the course of papers or discussions at the Institution meetings, or photographs of well-known electrical men. We should not like to anticipate for our readers the many surprises that are laid up for them as they daily strip off a slip in eager search for the day's electrical text, so we will not review the contents in detail. Our destructive bump, however, has compelled us to strip our copy to pieces in order to write this notice, and after what we have seen we can safely say that the 1904 Calendar will be acceptable to the central station, works, and office engineer as was that of 1903.

Once again we have been favoured by the Brush Electrical Engineering Co. with copies of their vest-pocket diaries, which will be among our most constant companions during the coming year.

A small price list of stretchless leather belting has come to hand from Messrs. H. F. Cockill & Sons, Ltd., of Cleckheaton.

Messrs. Callender's Cable and Construction Co., Ltd., have issued a catalogue (125 pp.) divided into eight sections, giving numerous drawings and particulars of their various feeder pillars and joint boxes, thus:—Section I. Standard lighting and tramway pillars; II. Callender-Ward network manholes; III. Mushroom type of network boxes; IV. Standard straight jointer boxes; V. Service boxes; VI. Dividing boxes; VII. House service fuse boxes; VIII. Frames and covers. In Section VII. are given particulars of the Callender-Ward fuse boxes, which are a totally new design, and are about to be placed on the market. We understand that the book contains a number of original designs which the company have recently introduced for their future standards, and which they hope to be in a position to stock in large quantities in the coming year for prompt delivery.

The Union Electric Co., Ltd., of Queen Victoria Street, E.C., have sent us an advance copy of their list of "E. V." pattern arc lamps, which are claimed to present considerable advantages over their old "H. V." and "D. V." lamps. They have succeeded in making the lamp very small, and at the same time maintaining from 100 to 120 burning hours; and have also eliminated the net work and ash tray, which somewhat detracted from the advantages of their previous form of enclosed arc lamps. It is also claimed that a perfectly white and brilliant light is obtained. Every part is standard and interchangeable, and the case and all the rods are insulated from the circuit either by mica or glass beads.

Messrs. Geipel & Lange have sent us one of their small pocket diaries for 1904. It is a convenient Letts's self-opening diary, containing a £1,000 railway or tramway accident insurance policy. There are also some useful engineering tables, which have been selected and arranged by Mr. Geipel. We would suggest that in next year's edition the firm should leave the front cover without its gilded lettering; the diary might then stand a better chance of being employed by some who hardly care to make use of it with its present bold advertisement.

A catalogue of insulators, in glass and porcelain, for voltages up to 100,000 volts, has come to hand from the Locke Insulator Manufacturing Co., of Victor, N.Y.

Mr. James Hendry, of Glasgow, is keeping his patent laminated leather beltings before the buyer by means of a desk calendar with monthly sheets, a complete calendar for the year 1904 being pasted on to the back for reference, as required.

A very acceptable gift has reached us from the British Electric Transformer Co., Ltd, of Hayes, in the form of an exquisitely bound copy of our old and indispensable friend, *Whittaker's Almanack* for 1904. Some additional pages which have been bound in, give particulars respecting the company, some of its customers among corporations and well-known firms, its manufactory, with many excellent pictures showing the Berry transformer complete and in part, and the different departments at the works, also a photograph of a bank (4,825 H.P.) of 200-KW. two-phase 10,000-volt transformer sets which it recently supplied. Many a friend of the company will welcome a copy of the Berry-Whittaker at this time.

A new price list has just been issued by Electric Lighting Boards, Ltd., of 80, York Road, King's Cross, N. The system of lighting and illumination is well-known to our readers as the E.L.B. system, and we understand that during the last 18 months a large number of temporary installations for exhibitions, &c., up to 5,000 lights have been carried out The Council is busy at the present time, and it is making a speciality of electric signs in various forms. The list contains several additional lines.

Messrs. J. Halden & Co., of Manchester, have brought out a wall calendar with tear-off monthly sheets, but we dare believe that the matter relating to the firm's addresses, &c., is so imposingly and largely displayed that the calendar matter is somewhat obscured.

Type No. 78 switch fuses are particularised in the latest list issued by Messrs. E. F. Moy, Ltd.

Bankruptcy Proceedings.—A statement of the affairs of John Webster Nicholson Star, electrical engineer, 29, Grange Road, Dudley, has been issued by the Official Receiver. The statement shows the gross liabilities to be £319 10s. 1d., and the assets *nil*. The alleged causes of failure are bad debts, losses on contracts, the profits from the business being insufficient to meet business and personal expenses. The bankrupt is 53 years of age, and states that he commenced business about ten years ago as an electrical engineer, under the style of Webster, Nicholson & Co., with a capital of £90. In November, 1902, he disposed of the business to a limited liability company, and he has since been engaged as traveller for the company at a weekly salary of 30s. He states that he received no cash payment for his interest in the business, but only 1,000 £1 shares in the company. These shares, which he now values at £50, have been deposited with his solicitor as security for costs to the amount of £70. The receiving order was made on the petition of the debtor's banker, to whom he owed £73. At the date of the receiving order seven creditors had obtained judgment against him.

Dissolutions and Liquidations.—Creditors of the Northern Counties Traction Co., which is winding up voluntarily, should send particulars of their debts, &c., to the liquidator (Mr. W. C. Spencer, North John Street, Liverpool) by January 19th.

Creditors of the Midland Telephone Press Agency should send particulars of debts, &c., to Mr. A. E. Winkles, 27, Icknield Street, Birmingham, by February 8th.

Trade Announcements.—Mr. W. H. Isherwood having left the firm of S. Dixon & Son, Ltd., of Leeds, has commenced business under the style of W. H. Isherwood & Co., electrical and mechanical engineers, at Carlton Mills, Leeds, where he will manufacture switchboards, main switches and tramway requisites.

Messrs. F. A. Robinson & Co., of 54, Old Broad Street, E.C., have taken into partnership Mr. M. H. Butcher, M.I.M.E., A.M.I.E.E., and Mr. A. E. T. Lees, M.I.C.E., who have been connected with the business for many years.

Mr. Robert Robson, of 5, St. Mary's Place, Newcastle-on-Tyne, has taken into partnership Mr. Arthur C. Coleman, his manager. The name of the business in future will be Robson & Coleman, electrical engineers, the address remaining as heretofore.

The offices of the British Mica Co., Ltd., have been removed to the factory at Lebanon Road Works, Wandsworth, S.W., and all communications should be sent to that address.

The name of the British Accumulator Co., of 15, Victoria Street, S.W., has been altered to the British Accumulator Co., *Ltd.*

The Union Cable Co., Ltd., have appointed Messrs. Palmer and Taylor, 50, Wellington Street, Glasgow, as their sole representatives in Scotland for electric cables and wires. A considerable stock will be held.

Ferranti, Ltd.—We are asked to state that, from January 1st, 1904, the sales administration of the company's meter department will be conducted from Donington House, Norfolk Street, W.C., by Mr. F. Barnes Spencer, M.I.E.E., as representing this branch of the company's manufactures. Both the continuous and alternating current types of meter are now entirely standardised for all sizes, and are manufactured throughout at the company's works, Hollinwood, Lancashire.

Books Received.—"Science Abstracts," Parts A and B. Vol. vi., part 12. London: E. and F. N. Spon, Ltd. 1s. 6d. each net.

"Proceedings of the Physical Society of London," December, 1903. London: Taylor & Francis.

Accumulator Factories.—We have received a copy of the Home Office regulations which come into force on January 1st respecting factory and workshop conditions governing the manufacture of electric accumulators. Copies may be obtained from Messrs. Eyre & Spottiswoode, the Government publishers, for one penny.

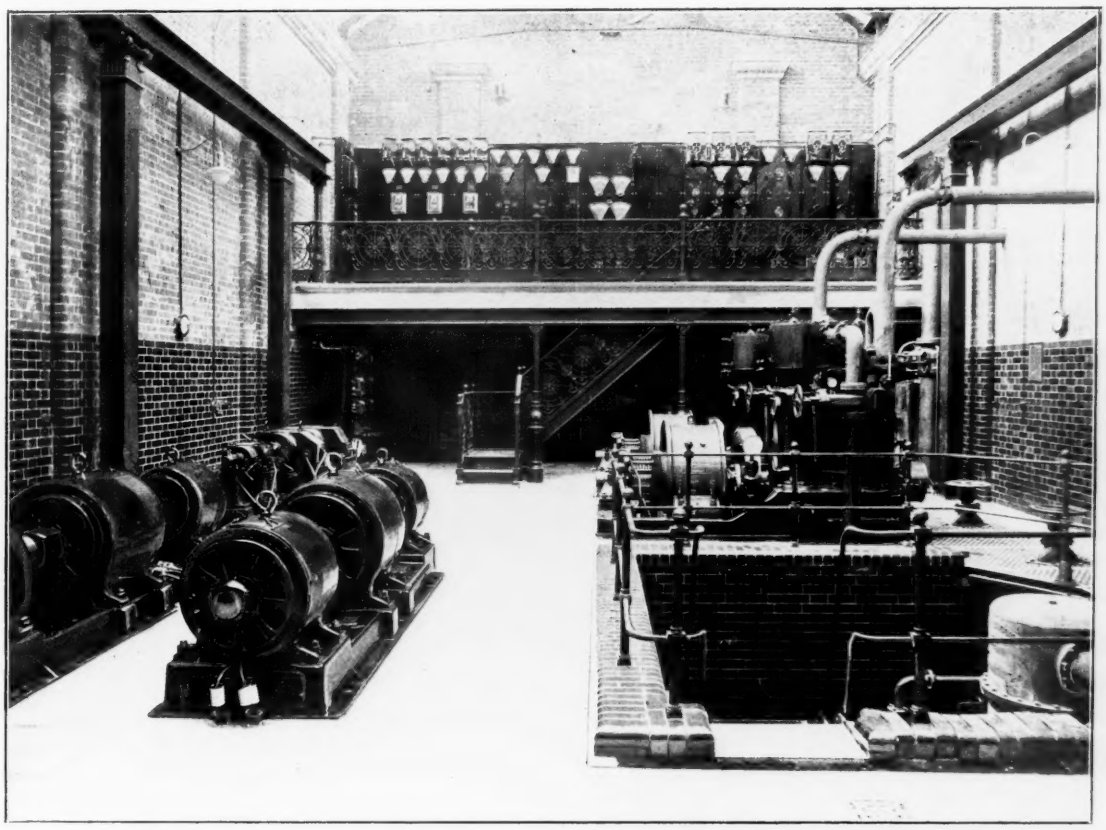
(*Continued on page* 23.)

CHRISTCHURCH ELECTRICITY WORKS.

The town of Christchurch, though it is quite overshadowed by its modern neighbour Bournemouth, has, with its Priory Church, its High Street and general air of antiquity, not to mention its famed salmon fishery, attractions not to be overlooked by anyone in search of a quiet life.

But its tranquillity has recently been disturbed by a modern spirit. Shortly the town will be connected to Bournemouth by a line of electric tramways which is to be constructed by the Corporation of the latter town. Already it is provided by the Bournemouth and Poole Electricity Supply Co., Ltd., with an electric works very completely equipped.

This company, with the assent of the Christchurch Corporation, obtained a provisional order in 1900, for, among other neighbouring districts, those of Christchurch and Southbourne, and decided to supply these areas from a new station rather than from their electric light and power station at Bourne Valley, on the other side of Bournemouth.



General View of Engine Room.

An excellent site with good foundations and water supply was secured near the centre of Christchurch, and on it have been erected substantial buildings in Bridgwater brick with Purbeck stone facings. The buildings were designed by Mr. A. G. Ware, M.S.A., of Bournemouth, acting in conjunction with the company's chief engineer, Mr. E. Ll. Ingram, M.I.E.E., who has been responsible for the specification and construction of the works throughout. The buildings were erected by Messrs. Wm. Hoare & Sons, of Bournemouth; they comprise engine and boiler house, battery room, offices, stores, &c., and are constructed to allow of extensions with the minimum of disturbance. The chimney, of circular section, was built in segmental Bridgewater bricks by the contractors for the main building, and is 110 ft. high × 5 ft. 6 in. internal diameter at the top.

Following the natural order of processes through the works, the town's water is first reduced from about 24° of hardness to 3° in a Desrumaux automatic water softener. Thence it gravitates to a cast-iron tank of 6,000 gallons capacity placed over the feed pumps in the boiler house. The feed pumps installed are a Weir steam pump of a capacity of 1,000 gallons per hour, and an electrically-driven variable throw pump of 600 gallons capacity per hour, made by Messrs. Mather & Platt, Ltd. In this latter pump the three barrels are arranged radially to the main shaft, and the plungers are driven from one crank pin carried eccentrically on a disc fitting into a recess in the end of the shaft, the recess itself being eccentric to the shaft. By means of gearing, which may be operated while the motor is running, the disc is rotated in its recess, and the throw of the crank pin varied from zero to maximum. The motor is thus kept running at a constant speed and high efficiency on all loads.

The water passes to the boiler through a Green economiser of 96 tubes, and a Beck hot-water meter. The economiser setting is arranged so that the number of tubes may be doubled without alteration. The feed pipe range is duplicated throughout, and is of lap-welded mild steel with solid welded steel flanges.

The water is evaporated in two Babcock & Wilcox water-tube boilers, each of 1,426 sq. ft. of heating surface, and fitted with superheaters. The working pressure is 150 lbs. per sq. in., and the steam temperature, 500° F. All the boiler fittings and high pressure stop valves are of Messrs. J. Hopkinson & Sons' make. The boiler house is 42 ft. 6 in. wide, 57 ft. long, and 23 ft. high to the roof plates, and has room for another pair of boilers. The coal bunkers, opening into the boiler house, have a capacity of 75 tons. The steam pipes, like the feed pipes, are of lap-welded mild steel with solid welded flanges, and with the exhaust pipes were supplied and erected by Messrs. Thomas Piggott & Co., Ltd.

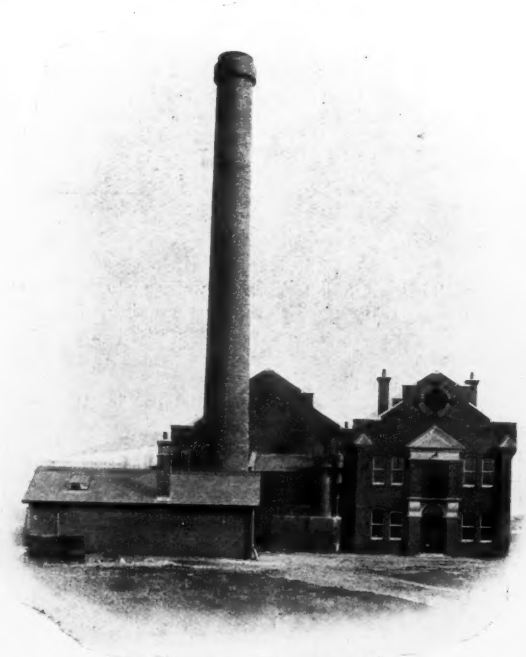
The engine room is of the same length and height as the

boiler house, and 30 ft. 9 in. wide. In it are at present installed two Belliss-Siemens steam dynamos, each of 100 KW. capacity, running at 450 r.p.m. By means of a by-pass valve operated by hand, an overload of 25 per cent. can be obtained for one hour. The plant was supplied by Messrs. Belliss and Morcom, Ltd., the engines being of their well-known type, and the dynamos having four poles, and giving 500 to 550 volts either as compound or shunt-wound machines for supplying power both for lighting and traction. In connection with the lighting supply, two motor balancers are provided, each of 25 KW. capacity. These machines were installed by the Brush Electrical Engineering Co., Ltd., and are fitted with Empire roller bearings. They answer several purposes, working with steam dynamos as balancers on the lighting system, the motor not excited, or, with the motor driven from the traction bus-bars, running as generators on the "day load," or, again, both as generators and balancers assisting the main lighting machines over the peak of the load. The roller bearings are fitted with a view to obtaining the highest possible efficiency while running for long hours on a light load.

Main Lighting and Traction Switchboard.

The condensing plant is below the floor level, and is of capacity to deal with the exhaust steam of the two engines erected, and of a third for which space is provided in the engine room. It includes a Holden and Brooke oil separator and automatic discharge trap. The air pump is electrically driven through worm gearing running in an oil bath. Messrs. Belliss and Morcom were the contractors for the plant. Circulating water is supplied from the River Avon by two electrically-driven 5-in. centritugal pumps made by Messrs. W. H. Allen, Sons and Co.

The battery, erected in single tier in a battery room over the



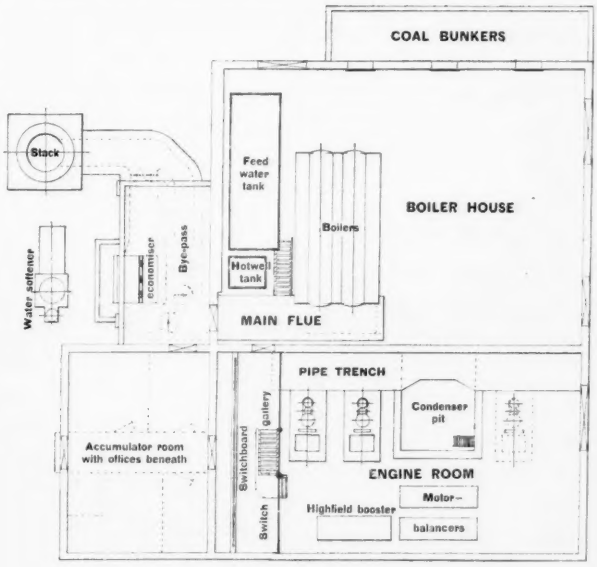
Exterior of Christchurch Electricity Works.

Nernst Lamp Column: Christchurch Public Lighting.

offices, consists of 244 Tudor cells in glass boxes, giving a discharge of 175 amperes for one hour. The battery room is spacious and well lighted, and is approached from the switchboard gallery. The charge and discharge of the battery, which is intended primarily for use on the traction bus-bars, is regulated by a Highfield booster—a machine too well known to require further description here.

The switchboard is built up of enamelled slate panels extending the full width of the engine room, and is placed on a gallery reached from the engine room floor by a flight of iron stairs. It contains the following panels, taken in order from right to left, viz.: Three traction feeder panels, motor panel, three dynamo panels, main instrument panel, middle wire panel, two balancer panels, and three lighting feeder panels. There are in addition a Board of Trade and a battery and booster panel, and several blank panels for future use. The contractors for the switchboard were Messrs. The British Thomson-Houston Company, Limited, and, with the exception of the recording instruments and earth switch, all the fittings are of their own make.

The switch gallery overlooks the engine room, and from it immediate access is gained to all the other parts of the works, with the exception of the circulating pump house, which is down by the river.



PLAN OF CHRISTCHURCH ELECTRICITY WORKS.

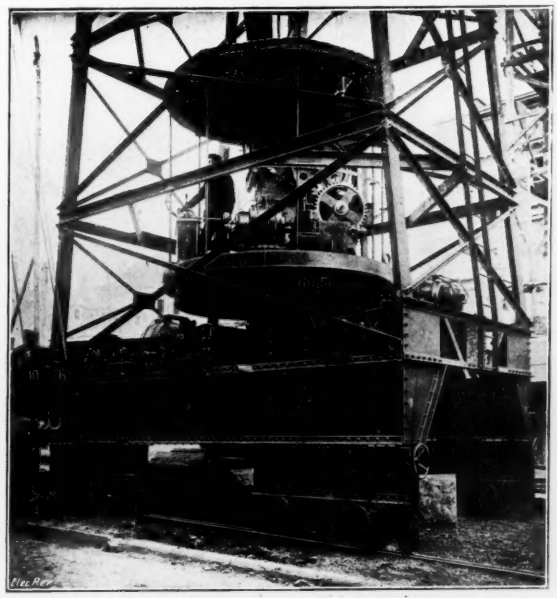
Distributing mains on the three-wire system, consisting partly of Glover's paper-insulated and partly of Callender's vulcanised bitumen-insulated cables, both makes without lead sheathing and laid in the Howard Conduit Co.'s asphaltic troughing, have been laid in 7½ miles of streets in Christchurch and Southbourne. The feeder, 1¾ miles long to the latter district, is a three-core paper-insulated lead-covered cable drawn into stoneware conduits. The pressure across the "outers" of the three-wire system is 500 volts, and the "declared pressure" 250 volts. This pressure was chosen as being the most economical in copper, and best suited to a station supplying also power for tramways.

The supply company has secured a contract for the public lighting of the Borough of Christchurch for a minimum period of five years, and for this purpose 65 Nernst lamps of 84 C.P. and 44 of 42 C.P. have been installed. The supply from Christchurch station was begun in June last, and at the present time there are the equivalent of 1,500 lamps of 8 C.P. connected to the mains.

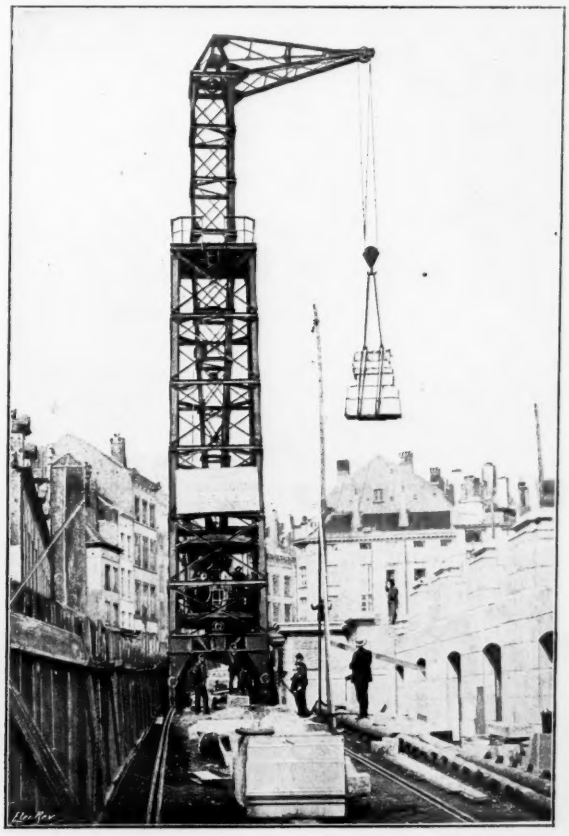
Mr. G. O. Nevile acted as the clerk of the works during construction, and Mr. J. E. Walley is the company's engineer resident in Christchurch.

A NEW ELECTRIC CRANE.

THE crane illustrated in the accompanying figures is one of a number constructed by the Gesellschaft für Elektrische Industrie, of Karlsruhe, for the construction of ships, the erection of buildings, &c., and has been recently employed in the erection of a barracks in Brussels. The special features of this type of crane are its great size, power and rapidity of working, its safety in operation, and the ease with which it can be erected and dismounted. The building in question was 23 m. high and 200 m. long.



MECHANISM OF ELECTRIC CRANE.



ELECTRIC CRANE AT WORK.

The crane is equipped with three motors, and is capable of raising a load of 10 tons to a height of 23·9 m. It runs

upon a track of 3·25 m. gauge, and has a maximum width of 3·85 m., the latter dimension having been kept as small as possible on account of the narrowness of the street.

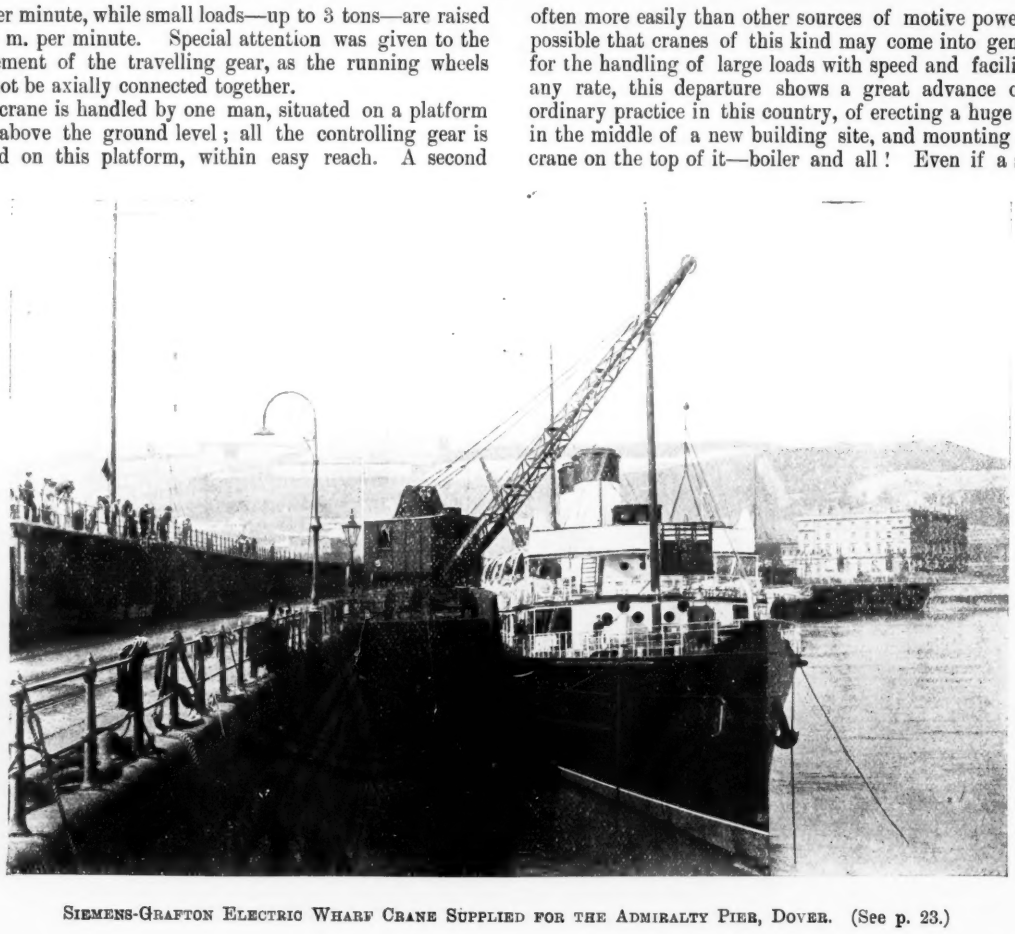
The crane can raise the full load of 10 tons at a speed of 5 m. per minute, while small loads—up to 3 tons—are raised at 17·5 m. per minute. Special attention was given to the arrangement of the travelling gear, as the running wheels could not be axially connected together.

The crane is handled by one man, situated on a platform 3·5 m. above the ground level; all the controlling gear is mounted on this platform, within easy reach. A second platform at a height of about 15 m., surrounded by a hand-rail, provides for the surveillance of the work, and for the transmission of orders to the driver when placing very large stones at great heights.

The crane, which can be shortened if desired to suit lower buildings, is provided with automatic devices to prevent over-winding and over-loading.

As electric power is now available almost everywhere—often more easily than other sources of motive power—it is possible that cranes of this kind may come into general use for the handling of large loads with speed and facility. At any rate, this departure shows a great advance over the ordinary practice in this country, of erecting a huge derrick in the middle of a new building site, and mounting a steam crane on the top of it—boiler and all! Even if a separate generating plant had to be put down on the site, there would be many advantages resulting; power would be available at cheap rates over the whole of the works, as well as for lighting and electric welding, and much time

Siemens-Grafton Electric Travelling Crane for the Admiralty Pier, Dover (See p. 23.)



Siemens-Grafton Electric Wharf Crane Supplied for the Admiralty Pier, Dover. (See p. 23.)

would be saved both in commencing and in completing the work of erection.

It must be admitted that builders and others engaged in similar work are not as yet fully awake to the enormous scope of electricity in aiding their operations.

THE ELECTRIC CRANES AT ADMIRALTY PIER, DOVER.

Two electrically-driven jib cranes were some little time ago erected on the Admiralty Pier, Dover, with the object of facilitating and accelerating the transhipment of passengers' baggage, mails and express parcels, to and from trains and Channel steamers; they were designed to lift the goods in boxes or crates of a gross weight not exceeding 3½ tons, and are shown in the illustrations which appear on the opposite page.

One of the cranes has been erected on No. 3 East Landing Stage of the Pier, and the other has been erected at No. 1 West Landing Stage above the parapet of the Pier.

Each crane is constructed for lifting a maximum load not exceeding 4 tons at a maximum radius of 55 ft., and slewing or travelling with these loads suspended from the jib in any position without being blocked or clipped to the rails.

The cranes are fitted with four motions, viz., hoisting, slewing, derricking and travelling; the radius is variable up to a maximum of 55 ft., and the jib (which is constructed specially light so as to offer little resistance to the wind pressure) measures 60 ft. centres in length. The gauge of the rails is 10 ft., and the total net weight of each crane in working order is 53 tons.

The cranes were constructed to the general specification drawn up by the engineer of the Dover Harbour Board, Mr. A. T. Walmisley, M.I.C.E., Messrs. Preece & Cardew, of Westminster, being the consulting electrical engineers.

The cranes were constructed and the details of the mechanism set out by Messrs. Grafton & Co., of Vulcan Works, Bedford, and Messrs. Siemens Bros. & Co., Ltd., supplied the electrical equipment.

The framework of the cranes is of a simple kind, and of Siemens-Martin mild steel; the whole of the gearing is in steel, the quick working gearing being machine cut. The current is supplied by the Dover Electricity Supply Co., Ltd., from 500-volt tramway generators.

The motors are series wound, and there are two on each crane:—Hoisting motor giving 37 B.H.P. at 420 revolutions per minute; slewing motor giving 18 B.H.P. at 310 revolutions per minute. The latter operates also the derricking and travelling motions.

As the cranes are in an exposed position, special provision has been made for slewing against the wind, the motors provided being of greater power than would be necessary under ordinary conditions.

Two brakes are fitted to the hoisting gear, one being automatic and worked by an electric magnet, and so arranged that the act of switching off current after hoisting applies the brake, and *vice versâ*. The second, or emergency, brake is operated by the driver's foot, and is capable of arresting the falling test load.

The controller is of the Universal type, the direction of hook and load following the direction of the driver's hand, *e.g.*, if the lever is raised, the crane hoists, and so on.

The speeds of the various motions are as follows:—Hoisting, full load at 120 ft. per minute; lighter loads at proportionally greater speeds. Slewing, with full load, one complete turn of crane 350 ft. travel of jib head in 40 seconds; slewing, empty, 2 revolutions of crane per minute; derricking, from maximum to minimum radius in 1 minute; travelling, 100 ft. per minute.

BUSINESS NOTES.

(*Continued from page* 18.)

Easton & Co., Ltd.—A meeting of creditors of this company was held at the Guildhall Tavern, E.C., on Tuesday last, December 29th. The summary of the statement of affairs submitted to the meeting by Mr. W. B. Peat, the liquidator, shows a deficiency of £125,307. The total assets charged as security for debenture stock, and the "B" debentures, amount to £224,521, but these classes and interest stand at £226,250, so that there is a deficiency of assets (subject to realisation and costs of liquidation) to meet the claims of the "B" holders of £1,729. The unsecured creditors are £23,554, and the shareholders' capital £100,025.

Toronto (Canada).—A new company, the Stark T., L. and P.M. System, Ltd., (telephone, light and power), capital $1,000,000, has been formed in Toronto, Canada, to take over the Humber Light and Power Co., Ltd., at Toronto Junction. The new company will operate the Stark patents, whereby telegraph, telephone, light and power service is furnished from the one plant and over the same circuit. It will greatly increase the Humber Light and Power Co.'s plant, and will immediately commence installing a telephone service in Toronto Junction, for which town it has received the franchise.

Motor-Car Industry.—The *Autocar* has compiled some tables showing that the number of cars exported from this country during the 11 months ended November last was 814, against 331 during the corresponding period of 1902, while the value of the vehicles was £289,307 for 1903, against £138,748 for 1902. The number of cars imported has also increased from 3,577 during the 11 months of 1902, to 5,892 in 1903, and the value of imported cars has increased from £1,041,091 for 1902, to £1,901,356 for 1903, this increase being mainly due to the inability of the English manufacturers to supply the great demand that has arisen.

Electrical Exhibition at Warsaw.—An electrical exhibition is to be held at Warsaw from May to September, 1904, Foreign exhibitors are invited to take part in the exhibition, which will include a special section for new electrical inventions. Exhibits will be admitted free of duty. All communications should be addressed to the Committee, Philharmonia Building, Moniuszki Street, Warsaw.

South Lancashire Electric Traction and Power Co., Ltd.—The case of Forwood *v.* the South Lancashire Electric Traction and Power Co., Ltd., came before Vice-Chancellor Hall, in the Lancashire Chancery Court, Manchester, last week. At a previous hearing the Vice-Chancellor had ruled that certain resolutions passed by the company authorising the issue of further mortgage debentures to the amount of £600,000, to rank in priority with respect to the present first mortgage debentures, were valid. A question was now raised by Mr. Stuart Deacon, on behalf of the existing debenture holders, as to whether among the assets charged by the new issue, were included certain policies of insurance which were mentioned in the trust deed as having been effected for the purpose of redeeming the old debentures. The new stock had not been issued. The point was of importance, because the company wished to know whether the policies were part of the security that could be offered to the new debenture holders. On behalf of the company it was argued by Mr. Rotch that the policies were certainly included in the other assets. The Vice-Chancellor said that it raised a very serious question. He doubted whether the debenture holders would have passed the resolution if they had known that the policies were to be included. The policies were redeemable on the very day on which the existing debentures were repayable. He directed that the matter should stand over until the first sitting of the Court at Liverpool.

ELECTRIC LIGHT AND POWER NOTES.

Atalanta, Ga., U.S.A.—The Atalanta Water and Electric Power Co. are constructing a masonry dam across the Chattahoochee River, and by the middle of next year they will have in operation an 11,000-H.P. generating plant for lighting and power purposes, half of the power has been already engaged in advance by newly-established enterprises. The present power represents 45,000 KW., and the company contemplate a still further addition to their plant.

Barking.—The U.D.C. has decided not to entertain an offer from the Empire Electric Light and Power Co., Ltd., for the leasing of the E.L. and tramway undertakings for a period of 21 years.

Beckenham.—The U.D.C. has decided to take counsel's opinion on the question of liability of the Council to pay income-tax on the E.L. undertaking, which has so far yielded no profit. The Commissioners of Inland Revenue claim £187.

Beeston.—The Derbyshire and Nottinghamshire Electric Power Co. has informed the T.C. that the cost of the necessary plant for the lighting of the town would be about £4,250, and that it is willing to enter into an agreement with the T.C. to supply it with energy in bulk, the minimum being 100,000 units per annum at 1½d. per unit, which would be distributed to consumers at 4½d. for lighting, and 2d. to 2½d. for power.

Bishop Auckland.—Application has been made to the Board of Trade by the Urban Electric Supply Co. to amend the Bishop Auckland Electric Lighting Order, of 1900, by substituting the County of Durham Electrical Power Distribution Co., Ltd., of Donington House, W.C., and by amending the sections relating to purchase and method of charging.

Bispham.—The Lighting Committee contemplates approaching the Tramway Co. with a view to getting overhead cables taken into the village for the purpose of street lighting.

Bristol.—Electricity users in the Bristol area experienced an unpleasant shock on the evening of December 23rd last, when the electric supply throughout the city failed, through a fire at the Temple Back generating station. Early on the following day a partial supply was again available from the new Avonbank station, and during the day the supply gradually assumed the normal condition. The matter is referred to in detail elsewhere in our columns.

Chippenham.—At a meeting of the Ratepayers' Protection Association a resolution was unanimously passed expressing the opinion that if a prov. order were granted, the Corporation should neither itself undertake an electric lighting scheme nor provide public money in order to enable any private company to do so.

Coventry.—The T.C. has adopted the recommendation of the E.L. Committee to apply to the L.G.B. for sanction to borrow £31,575 for the extensions provided for in Mr. Jeckell's report. Sanction has already been obtained for the spending of £38,676, part of an expenditure of £75,000 recommended by Mr. Jeckell in 1902.

The report, as drawn up a short time ago by the electrical engineer, provides for an expenditure to the amount for which sanction is to be obtained as follows:—

Mains	£12,000
New sub-stations	2,000
Transformers	3,000
Services to consumers, with meters, &c.	3,000
New generating plant	11,575
Total	£31,575

The capital then spent will be as follows:—

Capital spent up to March 31st, 1901	£75,813
Capital spent from April 1st, 1901, to present time	27,509
Owing on contracts already carried out	2,511
Extensions now in progress	8,656
Extensions probable in next two years	31,575
Extensions in succeeding year or two	4,000
Total	£150,064

The £2,000 spent, and the £5,000 asked for, in connection with the hiring out of motors, is not taken into account, as the hire of these provides the interest and sinking fund on the capital spent. About 500 H.P. of motors has been connected during the last twelve months, and orders for 200 H.P. more have been received, consumers finding that electric driving is cheaper and more convenient than gas engines. The capital in July, 1901, was £75,813, and the earning capacity of the station 350 KW., and the cost per unit 3·12d. At the present time the capital is £114,489, the earning capacity 900 KW., and the cost 1·82d. per unit. When the extensions are completed, the capital will be £150,000, the earning capacity 1,500 KW., and the cost per unit 1·44d., saving thereby on the cost in 1901, 1·68d. per unit.

Dunfermline.—Negotiations have been opened between the Fife Electric Power Co. and the T.C. with a view to the introduction of electricity to the burgh. No arrangement has yet been made, but it is stated that the company is prepared to establish a generating station at a point near the town and supply electricity in bulk to the Corporation.

Dorchester.—The E.L. Committee of the Corporation is negotiating for the leasing of its prov. order to a private company.

Dursley.—The T.C. has received application from the Gloucestershire Electric Power Co. for its consent to the granting of a prov. order for electric lighting of the Council's area.

East Ham.—A L.G.B. inquiry was held on December 22nd relative to the application of the U.D.C. to raise a loan of £15,000 for E.L. purposes. Mr. W. C. Ullman, the electrical engineer, stated that in order to meet next winter's load it was absolutely necessary to make considerable additions to the generating plant, and it was proposed to erect one 750-KW. direct-coupled engine and generator and a motor-generator-balancer set. Two additional boilers, a 1,000-H.P. condenser, and a 3,000-gallon capacity heater and detartariser were also required, while the switchboard would have to be extended. There was no opposition.

Elgin, N.B.—Mr. D. J. Russell Duncan has prepared a scheme for the consideration of the T.C., for the lighting of the district. He suggests that the source of power should be the River Lossie, and that a dam should be constructed at Little Ess. The proposed plant includes two turbo-generators for supplying three-phase H.T. alternating current at 5,000 volts. The water volume is estimated at 1,630 cb. ft. per minute, and there would be sufficient power to more than maintain 60 arc and 10,000 8-C.P. incandescent lamps.

Ely.—The U.D.C. has resolved to support the Southern District Electricity Corporation in applying for powers to light its area, subject to certain conditions.

Exeter.—The Heavitree District Council wrote stating that it would be prepared to consider any terms which the T.C. might suggest for the lighting of Heavitree by electricity.

Glasgow.—The Electricity Sub-Committee has received deputations from the burghs of Pollokshaws and Ruthengen in connection with the proposal that Glasgow should take over the electric lighting orders granted to these authorities.

Gravesend.—Northfleet U.D.C., being anxious to farm its E.L. order, has again approached the Gravesend T.C. on the matter. The latter has replied that it is unable to make any offer to acquire the order, but might be prepared to supply energy in bulk upon terms to be arranged.

Ham.—The Electric Lighting Co. has informed the U.D.C. that it will charge consumers at Ham exactly the same prices as in the rest of the district, viz.:—Maximum demand system, 7d. per unit for the first hour and 3d. afterwards, with an option of a flat rate of 6d.; for public lighting 2½d. per unit.

Johnstone.—A deputation from the Clyde Valley Electric Power Co. has had a conference with the T.C. in regard to the company's application for a prov. order to proceed with the scheme for lighting the town. The company has already authority to provide electrical power, and now wants powers for lighting.

Kilmalcolm, N.B.—The inauguration of the electric light took place 24th ult. In May last a prov. order for the lighting of the town was obtained by the Kilmalcolm Electric Lighting Co., and about three miles of mains have been laid. The plant comprises one engine and two generators and a battery of accumulators installed in a corrugated iron building. Feed water is supplied from a stream flowing past the station. Energy is to be supplied to consumers at 6d. per unit. The resident engineer is Mr. James Brown.

Kimberley.—It was stated at a meeting of the T.C. a short time ago that the foundations of the electrical power station building, which was only recently erected, were giving way. The De Beers Co. state that they will be unable to supply the town with energy for another three months, and it is therefore expected that the supply would not be available before June at the earliest.

Kingston-upon-Thames.—The U.D.C. has resolved to apply to the L.G.B. for sanction to provide additional plant for the lighting of the infirmaries, &c., and also for the provision of machine tools for the electricity works. The question of defraying the cost of the work, about £1,400, has been referred to Committee.

Lancaster.—The Town Council is spending £300 on new arc lamps at Skerton.

Leicester.—A L.G.B. inquiry has been held into the application of the T.C. to borrow £100,000 for electric lighting purposes. The total capital expended up to the present time is £173,982.

Liversedge.—The U.D.C. has received from the B. of T. a notification to the effect that the question of the revocation of the E.L. order will be deferred for a year.

London.—FULHAM.—The B.C. has sanctioned the construction of three more sub-stations, at an estimated cost of £1,800; also an extension of the mains along Crabtree Lane, at a cost of about £1,000.

Mr. A. J. Fuller, the borough electrical engineer, is preparing a special report dealing with the conversion of the whole of the side street lighting from gas to electric incandescent lighting, and probably a trial will be made of some 200 or 300 lamps. The weekly output has more than doubled itself in comparison with the corresponding period of last year, and since March last the consumers have increased from 650 to 1,020. The motor load of 40 H.P. at the beginning of March last has increased to 300 H.P.

STEPNEY.—The Finance Committee of the B.C. will, at the next meeting of that body, bring up an important report with reference to the electrical undertaking of the Council. In order to cope with the anticipated demands for next winter it is necessary to at once extend the installation. The expenditure of a sum of £78,200 is involved.

MARYLEBONE.—The Mayor has convened a public meeting for the 19th inst., to consider the question of promoting a Bill in the ensuing Parliamentary session enabling the B.C. to raise a loan for the completion of the purchase of the Marylebone undertaking of the Metropolitan Electric Supply Co., and for the provision of a new generating station admitting of a direct supply and of a self-contained system.

BROMPTON AND KENSINGTON.—The report of the preliminary B. of T. inquiry into the cause of the explosion of two cast-iron tee-pieces at the company's works in August last, states that the circumstances point to water-hammer action, set up by the presence of water in the pipes of a lower temperature than the steam that was admitted into them before the explosion occurred. One of the drain valves was found to be shut and the other choked.

Maidstone.—The T.C. has made the following additions to the tariffs in force for daylight supply of energy to consumers not requiring a supply during October and February from 5.30 p.m. to 8 p.m., November and January between 5 p.m. and 8 p.m., and December between 4.30 p.m. and 8 p.m.:—Supply at 1d. per unit, with £1 per annum for rental and winding of time switch.

Manchester.—Some figures presented to the Electricity Committee recently, show the progress which is being made in the supply of energy. The total output from the stations within the city, during the four weeks ended December 19th was 3,606,372 units, as against 2,539,368 for the corresponding period of 1902—an increase of 1,067,004 units, or 42 per cent. There appears to be little doubt that the estimated output for 1903, viz., 27,500,000 units, will be realised.

Melbourne.—The electric light department of the City Council shows the following results for the past few years:—

	Capital expenditure.	Available for interest and sinking fund.	Carried to reserves.
1897	£105,218	£8,123	£3,913
1898	106,592	6,854	2,591
1899	108,640	9,495	5,149
(Sinking fund raised from 2½ to 3 per cent.)			
1900	119,403	12,031	7,585
1901	204,051	11,265	6,686
1902	289,425	2,684	—
1903	324,149	22,656	10,865

In the foregoing, sinking fund is included among reserves. 1902 was a transition year. Two or three private electric supply undertakings were bought out, and, for a considerable time, had to be run separately. It is estimated that if the whole business could have been conducted as it is being conducted now, about £15,000 would have been saved in the year's expenditure. The capital now stands at £300,000; the extra £24,149 spent on capital account has been provided out of bank overdraft. Including the sinking fund, the reserves now amount to £33,415; that is to say, the sinking fund amounts to £40,985, but the debit balance on profit and loss account is £7,570, leaving the reserve mentioned. Of these reserves, £30,350 is invested in the Town Fund. The charge per unit has been reduced from 6d., flat rate, in 1897, to from 3d. to 5½d. in 1903. After allowing 3 per cent. for sinking fund, the return in the past year on the capital (£300,000) was equal to £4 6s. 2d. per cent.

Newton.—The U.C. has decided to oppose the application of the Urban Electric Supply Co. for an extension of its order into the parishes of Kingsleighton, Highwick and Milber, except on terms approved by the Council.

Southport.—The charge for power commencing from January 1st will be changed to 2d. per unit, and 1½d. per unit if the consumption of electrical energy equals 350 units per quarter per B.H.P. installed.

Stoke-on-Trent.—The T.C. has decided to canvass the town in order to ascertain the probable number of consumers of electricity for lighting and power purposes.

Tewkesbury.—The Southern District Electricity Corporation has notified the T.C. that it intends to apply for a prov. order to supply electricity to the borough. The T.C. will not assent to the application.

Warsaw.—It is intended to hold an electrical exhibition in the above town, with a special section for new electrical inventions, and it is stated that exhibits will be admitted free of duty. The address of the committee is Philharmonia Buildings, Moniuszki Street, Warsaw.

Watford.—The R.D.C. on December 16th decided to oppose the application of the U.D.C. for a prov. order to supply energy within the area of the R.D.C.

TRAMWAY AND RAILWAY NOTES.

Birmingham.—Some doubt having been expressed as to the completion of the first route to be electrified by the beginning of the New Year, an extra effort was made, and the Corporation has now been successful in getting the B. of T. inspection successfully passed. Col. Yorke and Mr. Trotter both went over the first completed portion—viz, Aston Road route—on December 29th, accompanied by the Mayor and several other gentlemen. The line will be opened to the public without ceremony on January 4th, 1904, with the workmen's cars. The power will be obtained, as already stated, from the neighbouring borough of Aston Manor, which has entered into an agreement to supply current for this route to 1906. The speed limit has been fixed at 10 miles per hour.

Cardiff.—Some 105 electric cars were at a standstill for 20 minutes on the night of December 24th. The account of the affair, which appears in the local paper, attributes the responsibility to a discharged workman, who had obtained access to the power station at Roath, and getting at the back of the board had disconnected a 2,000-H.P. generator which was running at the time. As a reward for his wrong-doing he received a very severe shock, and fell off the platform to the ground, a distance of 8 ft. The pressure at Roath is 500 volts, and it is stated that the man remained unconscious throughout the night.

Chicago.—Up to December 11th the labour troubles with the car conductors and motormen of the Chicago Union Traction Co. had not been settled. There have been several street riots, and even firearms have been used in disputes arising out of the employment of non-union men on such cars as have been running.

Dumbarton.—At a meeting of the inhabitants of Bowling and Milton, on 17th ult., it was agreed to unanimously support the proposed scheme of local tramways. The scheme comprises the running of cars from Ballonk to Dumbarton, the Electric Supply Corporation, Ltd., London, having acquired the Dumbarton Burgh Tramway Provisional Order, and the intention of the promoters of the meeting was to get the County Council to give every facility to the same company to continue the tramways to join the Glasgow Corporation system at Dalmuir.

Glasgow.—The Tramways Sub-Committee of the T.C. has had again under consideration the question of the extension of the ½d. fare stages. It was agreed to recommend that no alteration be made.

Great Northern and City Railway.—The preamble of the Bill deposited by the company for the next Session states that the railway from Drayton Park to Moorgate Street is approaching completion, except a small portion near Moorgate Street, which can only be completed in conjunction with the extension from Moorgate Street to Lothbury, which was authorised in 1902. The company, therefore, asks Parliament to extend the time for completion until 1907, the date fixed for the completion of the Moorgate Street to Lothbury extension.

Holywood.—The project for connecting Belfast and Holywood by an electric tramway, has taken tangible shape. A Bill to promote the undertaking has been formally deposited, and other preliminaries arranged. The proposed line has a length of about 5 miles.

Lancaster.—Our local correspondent writes:—The Corporation is apparently troubled with the presence of some members who are interested in the horse traction tramway from Lancaster to Morecambe. Owing to the failure in the negotiations between the Lancaster Tramway Committee and the company as to the purchase of the old line—there was a difference of about £3,000, the company asking £30,000 and the Corporation offering £27,000—friction has arisen. The effect is seen whenever the Tramway Committee brings forward extension proposals. At the meeting on December 23rd, Mr. Alderman Smith (chairman of the Tramways Committee) had to reply to objections raised by Councillor A. Bell, who is chairman of the Tramway Co., and in doing so he proved conclusively that the proposed new route from the Castle Station to Dalton Square would pay better than the existing routes to the Park and Scotforth. The estimated cost was £8,041. Alderman Smith took the opportunity of telling the members of the Council who are interested in the Tramway Co. that it would look better if they abstained from the discussion on tramway matters. It is hoped this may have cleared the atmosphere, and that in future the progress of the Tramway Committee will not be barred. The engineer (Mr. W. A. Tester) was instructed to proceed with the new route.

Liverpool.—The Corporation's illuminated car, which has done such good service at times of public rejoicing, was especially got up to wish the populace of Liverpool a "Merry Christmas." It was decorated with white and coloured lights and Yule-tide mottoes wrought with incandescent lamps.

Liverpool—Southport Electric Railway.—Trial runs over this section were made last week.

London.—The section of the L.C.C. tramway system from Greenwich to the three Thames bridges is complete, and awaiting the official inspection of the B. of T. Trial cars have been run.

Manchester.—The working arrangements between the Corporations of Manchester and Ashton-under-Lyne, and the Urban District Councils of Altrincham, Withington, Audenshaw and Droylsden, with reference to the tramways connecting the city with the districts mentioned, will be settled by the Bill which is to be presented to Parliament next session. The agreement between Manchester and Ashton provides for the construction, or reconstruction, and electrical equipment by Manchester of the Audenshaw and Droylsden lines, and also for their maintenance; and the Ashton Corporation will enter into a similar undertaking as regards the lines within its own area. Each Corporation grants to the other running powers over its lines, but the net profits made by each in the other's district are to be handed over to the authority of the district in which they were made. In case of non-agreement as to amount, the matter will be settled by arbitration. The Manchester Corporation will supply the current needed for the tramway service in the city, and in Audenshaw and Droylsden; and the Ashton Corporation will perform a like service in its district. Neither Corporation is to transfer its rights over the other's lines without the consent of both parties. The only point of difference at present is as to the period for which the agreement is to continue. Manchester favours 21 years as between the city and Ashton, and that in Audenshaw and Droylsden the agreement should be coincident with its continuance between Manchester and Ashton. The Ashton Corporation, on the other hand, would prefer an agreement terminable by six months' notice on either side at any triennial period. Altrincham and Withington, of course, are not affected by the above arrangements. The terms, as between Manchester and each of these suburban districts, have been settled, and only await the sanction of Parliament. Some lengths of new line are to be authorised in Sale and Dunham Massey. The period of construction of the Withington tramways, authorised by a former Act, is to be extended for three years, and road improvements and widenings are to be made in Palatine Road, Wilmslow Road, and other thoroughfares leading into Manchester.

A sub-committee of the Manchester Tramways Committee has had an interview with representatives of the Heywood and Middleton

Corporations, with a view to the extension of the Rochdale Road lines from Middleton to Heywood. This would involve the making of a new road and other improvements. If it could be arranged this would prove of enormous service to both the towns mentioned. Heywood has long agitated for direct tramway connection with Manchester.

Newcastle-on-Tyne.—The second year of the working of the electric tramways under the Corporation has just closed. The receipts for the year have been £173,260, compared with £127,250 for the first year, an increase of £45,010. The number of passengers who travelled was 38,220,000, as against 28,250,000, or just ten millions more. There are 42 miles of track, and further extensions of the track are in contemplation.

Radcliffe.—The U.D.C. has resolved to promote a Bill in the next Session of Parliament seeking further powers with regard to electric tramways, to supply energy within and without the district, and to undertake the electric wiring and fitting of consumers' premises.

Rhosllanerchrugog.—The P.C. has held a special meeting to consider an important communication from the Electric Tramway Co. stating that it was not their intention to immediately construct the portion of tramway line from Johnstown to Rhos. After discussion it was resolved to refer the matter to the B. of T. and to the Wrexham R.D.C. with a view to compelling the company to carry out their original scheme, for which Parliamentary powers were obtained.

Rochdale.—As a result of a conference held *in camera* between representatives of Bury and Rochdale Corporations and other local bodies and the directors of the Bury, Rochdale and Oldham Tramway Co., it has been decided that notices shall be served on the company to sell to Rochdale T.C. so much of the undertaking as is within the borough. When the lines are taken over, they will be converted to electric traction.

Simplon Tunnel.—Reuter reports that great difficulties are being encountered in the boring of the Simplon tunnel on the northern side. The work has been interrupted by floods for four weeks. It is questioned whether the tunnel can be finished before next August at the earliest.

Wrexham.—It is stated that the Wrexham and District Electric Tramways Co. has decided to extend its lines to Ruabon and Cefn Mawr, and ultimately to Llangollen.

TELEGRAPH AND TELEPHONE NOTES.

Glasgow Telephones.—The annual dance of the employés of the National Telephone Co. (Glasgow District), one of the social functions of the season, took place in the Trades Hall on Thursday evening, December 24th.

Portsmouth Telephones.—At the last meeting of the T.C., the Telephone Committee submitted a recommendation that the town clerk be instructed to take proceedings against those persons who had not paid their subscriptions. Councillor Brewis said it seemed to him rather early for a new undertaking like that to have bad debts. He asked if they had any system of inquiring as to the trustworthiness or otherwise of would-be subscribers, and if they took references or deposits, or whether they connected up everybody in order to increase the number of their subscribers.—Mr. Dittman, chairman of the Committee, said these were not bad debts until the effort to get the money failed, and they hoped to get it all. They had 1,500 stations connected, and had failed to get the subscriptions from 32 persons only. They did not ask for payment in advance, but as soon as the instrument was put in they rendered the account, and almost invariably got the money.—The recommendation was adopted.

Telegraphic Interruptions and Repairs :—

CABLES.	INTERRUPTED.	REPAIRED.
Dominica-Martinique	May 5, 1902	
St. Lucia-Martinique	May 7, 1902	
Anjer-Kalianda	Aug. 2, 1902	
Cayenne-Pinheiro	Aug. 18, 1902	
St. Lucia-St. Vincent	Sept. 19, 1902	
Reissa-Issa (Yemen)-Camaran	Oct. 22, 1902	
Paramaribo-Cayenne	Feb. 26, 1903	
New York-Hayti	April 18, 1903	
Trinidad-Demerara No. 1	Aug. 27, 1901	
Tourane-Amoy	Nov. 10, 1903	
St. Jacques-Haiphong	Dec. 15, 1903	
St. Thomas-St. Kitts	Dec. 21, 1903	
Mole St. Nicolas-Port-au-Prince	Dec. 16, 1903	
St. Vincent-Grenada	Dec. 28, 1903	
LANDLINES.		
Rowno-Odessa	Dec. 14, 1903	Dec. 19, 1903
Odessa-Kertsch	Dec. 19, 1903	Dec. 29, 1903

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast. — January 15th. Electricity meters. See "Official Notices" December 25th.

Enniscorthy.—January 20th. Electric lighting and pumping plant (seven sections), for the Lunatic Asylum. See "Official Notices" December 4th.

Erith.—January 18th. Lancashire boilers, piping, condensing plant, three-phase steam alternator of 500 KW., switchboard and cable extensions. See "Official Notices" December 18th.

Fire Alarm Wiring.—January 6th. The May-Oatway Fire Appliances, Ltd., is inviting tenders for wiring several installations on its system. See "Official Notices" to-day.

Glasgow.—January 11th. Two 3,000-KW. 6,500-volt, three-phase turbo-alternators, and condensing plant; one 2,200-HP. engine and double current generator and transformers; six 500-KW. motor-generators or rotary converters, for the electricity department. See "Official Notices" to-day.

Glasgow, &c.—January 2nd. The May-Oatway Fire Appliances, Ltd., is inviting tenders for the carrying out of certain fire brigade installations of its automatic fire alarms. See "Official Notices" to-day.

Glasgow.—Tenders are invited by the Corporation Electricity Department for mild steel angle backs for new stores at Port Dundas Works.

Hackney.—January 4th, 1904. Feeding and distributing mains. See "Official Notices" December 11th.

Harrismith (Orange River).—January 18th. Cables, transformers, switchgear, &c. See "Official Notices" December 11th.

Kettering.—January 9th. Electricity meters. See "Official Notices" December 18th.

Lanark.—January 11th. The County Council and Middle Ward District Committee want tenders for refuse destructor and electric lighting plant, &c. Specifications, &c., from W. L. Douglass, district engineer, Hamilton.

L.C.C.—January 19th. Six electrically-driven three-throw boiler feed pumps for Greenwich power station. See "Official Notices" November 20th.

Pontypridd.—January 15th. Pipe work and electricity meters for the Council. See "Official Notices" to-day.

Spain.—February 12th. Concession for an electric tramway between Porrino and Mondariz (Pontevedra province). See "Contracts Open" December 18th.

Spain.—February 15th. The Public Harbour authorities at Barcelona are inviting tenders until February 15th for the contract for the establishment of the plant and equipment for the electric lighting of the sheds at the Port of Barcelonnette, and for the operation of the cranes, travellers, &c.

Sydney (N.S.W.).—January 12th, 1904. Messrs. Preece and Cardew want tenders for:—One or two 600-KW. or one 1,200-KW. three-phase steam alternators with condenser, pipework, motor-generators, transformers, switchboards, &c., and a coal and ash conveyor. See "Official Notices" December 11th.

Wallasey.—January 16th. Cables, joint and section boxes. See "Official Notices" December 18th.

Walthamstow.—January 1st. Permanent way, gas plant, engines, dynamos, batteries, switchboard, cables, overhead equipment, &c., for 11 miles of line. See "Official Notices" December 4th.

CLOSED.

Hebden Bridge.—The electricity works are nearing completion. The Committee has accepted the tender of Mr. R. S. Blackburn, for service cable connections for consumers' premises, and for other work in connection therewith.

Ipswich. — The Allgemeine Co. have placed an order with Messrs. Reavell & Co., Ltd., for a further 360-I.H.P. high speed engine, for the electricity works.

May-Oatway Installations.—The May-Oatway Fire Appliances, Ltd., have placed the contracts for the installations mentioned in our issue of the 11th ult. with the following firms:—For the premises of James Brown & Co., with the National Telephone Co.; for the Donside Paper Mills and Fiddes' Saw Mills, with Pratt, Keith & Co.; for Paxton's Box Works, with J. Kilpatrick and Sons; for the saw mills of John Young and Sons, with McAulay, Clark and McLaren; for Messrs. Sangster and Henderson's premises, with the Aberdeen Electrical Engineering Co.; and for the establishments of the Paisley Provident and Kinning Park Co-operative Societies, with Messrs. Allan, Arthur and Ure.

Radcliffe.—The U.D.C. has accepted the tender of Messrs. W. Metcalfe, Ltd., of Church, for the supply of coal tar pitch at 52s. 6d. per ton, and creosote oil at 2d. per gallon for the tramways; that of Messrs. Etheridge & Clark, for the erection of engine house platforms and switchboard gallery at the electricity works, at £168 6s. 4d.; and that of Messrs. J. G. Statter and Co., of Birmingham, for complete lighting switchboard and complete traction switchboard, at £1,345 12s. 6d.

The contract for the building work of the Lancashire Electric Power Co.'s first station at Radcliffe, has been let to Messrs. Robert Neill and Sons. The work is to be completed by Sept. 30, 1904.

FORTHCOMING EVENTS.

Tuesday, January 5th.—London Electrical Contractors' Association. Paper by R. B. Johnson on "The Necessity for the Standardisation of Wiring Rules."

NOTES.

South-Western Polytechnic, Chelsea.—The governing body of this Institute have accepted with very great regret the resignation of the Principal, Mr. Herbert Tomlinson, F.R.S. At their meeting held December 16th, 1903, the following resolution was passed:—"That the governing body hereby desire to record their cordial appreciation of the admirable work that Mr. Tomlinson, as the first principal, has accomplished in organising and developing the Institute in all its branches."

The Great Western Railway Electrification.—We are pleased to learn that the contract for engines, three-phase generators, condensing and auxiliary plant, aggregating about 10,000 H.P., for the Great Western Railway Co.'s new electricity generating station at Park Royal, has been secured by a British firm, namely, the Electric Construction Co., Ltd., of Wolverhampton. The announcement is also very acceptable, because it is a proof that the Great Western Railway Co. is moving in earnest in the direction of electrification.

Niagara Falls.—Gen. F. V. Greene, who retires from the position of Police Commissioner in New York City on the advent of the Tammany Administration on January 1st, has received an appointment which gives him charge of the plant of the Albright and Hayes Power Co., who are building new works on the Canadian side of the Niagara Falls.

Trials of Electrical Vehicles.—With regard to the trials of electrical vehicles which the Automobile Club of Great Britain and Ireland proposed to hold next year, we regret to learn that, owing to only two entries having been received, it has been decided not to proceed with the same.

The trials of electrical vehicles which the *Monde Sportif* proposed to hold last month, and which, owing to lack of entries, were postponed, are now to be held from March 27th to 30th next.

Electric Lighting and Tramway Companies as Colliery Owners.—Owing to the difficulty in obtaining regular supplies of coal last year, the Cincinnati Gas and Electric Co., and the Cincinnati Traction Co., of Cincinnati, U.S.A., are credited with a project for acquiring and working a colliery on their own account. The first-named company uses 200,000 tons of coal per year, and the Traction Co. 130,000 tons, and it is estimated that by drawing the supplies from their own colliery a large economy would be effected.

Fire at the Bristol Electrical Station.—The officials at the Corporation electrical works at Bristol will not readily forget Christmas of 1903. From Mr. Faraday Proctor, the engineer, downwards, they have had something more exciting to deal with than Christmas loads, it having been their unenviable experience to see their high-tension switchboard, from which all the alternating lighting of the city is controlled, burnt out by a fire which occurred at the very busiest time of the whole year. Those who have lately inspected the electrical arrangements at Bristol are aware that, owing to the Temple Back site in the centre of the city having become exhausted by repeated extensions, the Corporation had to launch out on the outskirts, and thus it has in existence to-day the earlier station crowded with plant, and the first, with part of a second, section of a new station a couple of miles away. At the new station at Avonbank, larger units have been adopted, and other changes made which have had the result of considerable economy as compared with the plant installed earlier in the history of the undertaking. The idea has been as things get beyond the transition stage, to centre the lighting work at Avonbank and use the older station at Temple Back for the production of power—a rapidly increasing branch of business. The two stations, although distant from each other, are at present worked together, and the general switchboard occupies a gallery at Temple Back. It was on this switchboard that the fire occurred, and the effect was to bring to a stop the whole of the Corporation supply.

There were all sorts of theories as to the nature of the accident, but as will be seen from the official explanation given by Mr. Faraday Proctor to a special meeting of his committee on Tuesday morning last, which we reproduce on another page, the origin of the fire is not yet definitely known.

The Electrical Committee expressed great appreciation of the assistance rendered by various gentlemen who had come specially into the city to supply stores required by the staff in their work of repairing the damage done by the fire; they also expressed their thanks to the engineer, secretary, and their respective staffs for the promptitude and zeal which they displayed in the emergency.

The Bristol people took the inconvenience involved by the stoppage of supply with very good temper. That the inconvenience and loss were serious, no one can doubt. On the evenings of the 23rd and 24th, retail shops were crowded with customers, and the toy bazaars were packed when the light failed. Lamps, candles and resurrected gas jets were utilised freely, but in many instances the total illumination from these makeshift arrangements was miserably inadequate to the needs of the case. After their one night's experience, shopkeepers would have made provision for a better light on Christmas Eve, but they were assured by the electrical authorities that the incandescent light would be available in full time This proved too sanguine a view, for the alternating current was not switched on until 7.30, and in some districts later in the evening. For several hours, therefore, the inconvenience of the previous evening was repeated. The only complaints heard were that the promise should not have been given unless it was certain to be realised. Quite a number of city offices had to close early on the 24th for want of light.

At the end of the Electrical Committee's last financial year, March 25th, 1903, there were 2,097 customers connected with the Corporation service, power connections being equal to 12,507 lamps and private lighting to 20,481 lamps. These figures have been considerably increased in the intervening nine months. For several years 310 direct current arc lamps have been used for lighting Bristol streets, and within the last few weeks the Committee have been completing a scheme of doubling this number by lighting many other thoroughfares. All these were on Wednesday night plunged into darkness for a few hours; the night was a black one, and the gloomy streets presented a weird appearance.

As we go to press a correspondent writes as follows:—

"The failure occurred on the single-phase alternating-current system at 2,000 volts. The whole of the distribution is from the switchgear at the old station, this switchgear being connected up by trunk mains to the new Avonbank switchgear. Both switchgears are of the Ferranti cellular type, the one at Temple Back being ordered from Messrs. Ferranti, Ltd., nearly five years ago. At the time of the accident the load of about 3,000 KW. was being taken up by two 400-KW. machines at Temple Back, and four 750-KW. machines at Avonbank.

"In such occurrences it is difficult to locate exactly the origin of the fault, but from the appearance of the switchgear it would seem that, for some reason yet to be discovered, one or both of the machine fuses at Temple Back blew. This action was apparently followed by a severe arc in the fuse panels, which burnt through the slate above it, melting the fuse contacts and the metallic connections between the fuses and the switches. It would appear from the *débris* that, although some minutes were taken to shut down the machines at Temple Back and Avonbank, the arc thus formed was confined to the machine panels. A serious conflagration, however, was almost simultaneous with the forming of the arc, the flames igniting the linoleum floor and the insulation over the inner conductor of the cables connecting to the terminals under the bottom switch slate. The flames from this material were intense, and quickly spread over the entire switchgear and to the roof of the building.

"A close examination on Thursday last week revealed the fact that the damage to the power station and machinery was not so extensive as was at first thought. The fire was confined to the wood-work used in the structure, the insulation on the cables and the flooring, although the water with which the fire was subdued impaired some portions of the plant. Great credit is due to Mr. H. Faraday Proctor and his assistants, Messrs. Cousens and Bolam, for the energetic way in which they coped with the most trying situation.

"Practically the whole of the cable work in the station had to be cleared, and in order to get down to the sound portions of some of the cables, it was necessary to dig up the road adjoining the electricity works. Although the Ferranti cellular switchgear is apparently at fault in that the fuse, which is of an obsolete type, failed, yet the arc caused by this failure was confined to the switch and fuse panels of three or four machines, the bus-bars (there are three inner bus-bars) remaining intact, thus giving a practical demonstration of the utility of the cellular construction in limiting to a minimum the extent of the arc. While admitting that the remainder of the switchgear, including the circuit section, was placed out of commission, it must be taken into consideration that the damage was not caused by a direct electrical failure on the individual section, but by the heat and smoke resulting from the combustion of materials which, although they were contiguous and near to the switchgear, did not form an inherent part of the actual cellular switchgear design."

Personal.—Mr. Thomas Browett requests us to state that he has resigned his position as joint managing director of Messrs. Browett, Lindley & Co., Ltd., of Patricroft, Manchester, and no longer holds a seat on the board. For the present his address will be 6, Old Queen Street, Westminster, S.W.

The Tramways Committee of Sheffield T.C. has recommended Mr. Arthur R. Fearnley, general manager of the Birkenhead municipal tramways, for the post of tramways manager at a salary of £700 a year.

Mr. Alfred Slatter, M.I.E.E., consulting electrical engineer, has removed to Effingham House, Arundel Street, Strand, W.C.

Lectures.—On December 19th Mr. John Gray, B.Sc., gave an Arnott lecture at Aberdeen on "What is Electricity?"

A paper on "Electric Equipment of Light Railways" was read before the Glasgow Institution of Civil Engineers on Monday, December 21st, by Mr. J. Malcolm Bell, B.A.C.

A special course of ten lectures on "Continuous-Current Motor Design" is to be delivered in the Glasgow and West of Scotland Technical College by Mr. W. Benison Hird, B.A (Cantab). The lectures commence on January 14th.

Appointments Vacant.—A draughtsman is wanted for the Lancaster Corporation tramways department; an installation foreman canvasser is required by Woolwich B.C. (£104 and a commission of 3d. per 8-C.P. connection); shift engineer (38s.) for Stretford electricity works; electrical engineering instructor for the C.T. College, Exhibition Road (£150).

THE CENTRAL STATION ENGINEER.

THE first annual dinner of the staff and employés of the Salford Corporation Electricity Department was held at the Horse Shoe Hotel, on Wednesday, December 16th, and was attended by Mr. Councillor HODGSON, deputy-chairman of the Electricity Committee, Mr. CHARLES D. TAITE, borough electrical engineer, and 108 members of the staff. An excellent dinner was followed by a most enjoyable smoking concert. Mr. Taite, who occupied the chair, proposed the toast of the "Electricity Undertaking," and said he considered that the borough and the staff were particularly fortunate in having well-known engineers like Mr. Alderman Shaw and Mr. Councillor Hodgson, at the head of affairs. The progress made by the undertaking was shown by the following figures:—1896, 52,000 units sold; 1899, 400,000; 1902, 1,250,000; 1903, 4,750,000. The number of lamps connected to the mains at the present time was equivalent to 100,000 8-C.P. lamps, and the total horse-power in motors, &c, amounts to nearly 2,000-H.P.

The results obtained for the year ending March 31st, 1903, were very satisfactory, and the technical papers with one accord expressed their appreciation of the result which had been achieved, but although the technical press were unanimous in their approval he regretted that the local press did not show the same appreciation. During the three years which he had spent in Salford, he had not seen in the local press one single word of approbation in connection with the electricity undertaking; this, he thought, was not quite fair, seeing that the same press was always ready to publish criticisms adverse to the undertaking. The hostile remarks of the press tended to retard progress by inspiring the ratepayers with a want of confidence in the undertaking, which was entirely uncalled for. He hoped that the local press would realise this fact, and would, in future, criticise them as fairly as did the technical journals. Mr. Taite referred to the number of men employed by the undertaking, and gave the following figures to show the increase which was taking place:—1898, number of men 89, weekly wage bill £111; 1901, 123 men, £172 wages; 1903, 146 men, £217 wages. He expressed his appreciation of the assistance received from the staff and men employed. He concluded by coupling with the toast of the "Electricity Undertaking" the name of Mr. Councillor Hodgson, deputy chairman of the Electricity Committee.

Mr. Councillor Hodgson, in responding, said that they had been blamed for needless expenditure in building a station too large for the requirements of the borough; but, though he was no prophet, and had not come there to prophesy, he had always said that the undertaking would prove itself to be too small in five years from the time of opening, and he was there that night to back that statement up, if necessary, by figures. In ordinary business, large concerns were never expected to make large profits for the first year or two, but that was what electricity works seemed to be expected to do.

Bradford Tramways Committee has promoted Mr. G. R. BLACKBURN, workshop engineer, to the position of assistant electrical engineer in the Tramways department, and Mr. JOHN FOSTER, foreman of the Thornbury depôt, to the post of rolling-stock superintendent.

Mr. H. E. YERBURY, assistant electrical engineer at Sheffield, has been promoted to the position of chief electrical engineer to take charge of the power station and all outside electrical work, at a yearly salary of £350.

Maidstone T.C. has appointed Mr. SAUNDERS outside electric light superintendent, and Mr. EMPSON inside superintendent. Messrs. GOULBURN and WILLIAMS have been appointed night shift assistants.

NEW COMPANIES REGISTERED.

General Rubber Co., Ltd. (79,496).—This company was registered on December 19th, with a capital of £500 in £1 shares, to carry on the business of manufacturers of rubber and rubber goods, cable makers, cycle manufacturers, wheelwrights, dealers in electric light requisites, &c. The first subscribers are:—A. W. Sing, Fernlea, Mossley Hill, Liverpool, stockbroker, 494 shares; R. P. Sing, Mill Hey, Eastham, Birkenhead, M.A., 1 share; M. P. Rathbone, 8, Sefton Drive, Liverpool, stockbroker, 1 share; D. Kirkpatrick, 20, Bristol Avenue, Egremont, cashier, 1 share; J. L. Smith, B.A., Hill Bank, Frankley, Birkenhead, 1 share; F. J. Angwin, 46, Bebington Road, Birkenhead, salesman, 1 share; and H. Hitchcock, 31, Barrington Road, Liverpool, clerk. No initial public issue. The holder of the largest number of shares shall be the first director.

Zone Dynamo and Motor Patents Co., Ltd. (79,568).—This company was registered on December 24th, with a capital of £2,700 in £1 shares (1,800 preference), to adopt an agreement between H. Edmunds, L. W. Holmes, and H. F. Joel of the first part, J. H. St. H. Mawdsley of the second part, the said L. W. Holmes of the third part, and A. Pratt (for this company) of the fourth part, to undertake and execute any contracts for works involving the supply, application, or use of dynamos, motors, and dynamo-electric machinery, and to carry on the business of electrical engineers and experts, technical advisers, consulting, mechanical, and general engineers, manufacturers of electric dynamos, motors, magnets, machines, generators, executers, boosters, motor-generators and transformers, electrical regulators, &c. The first subscribers (each with one preference share) are:—A. M. Pratt, 11, Victoria Villas, Maryland Road, Wood Green, N., clerk; J. W. A. Wywark, 148, Kennington Road, Lambeth, S.E., clerk; H. E. Colnett, 185, Turners Road, Bow, E., clerk; A. F. Sims, 10, Serjeants Inn, E.C., solicitor; R. C. Leach, 10, Serjeants Inn, E.C., solicitor; G. L. West, The Grange, Crescent Road, South Norwood, S.E., clerk; and R. Watt, 29, Pemberton Road, Harringay, clerk. No initial public issue. The number of directors is not to be less than three nor more than six; the first are H. Edmunds, L. W. Holmes, H. F. Joel, and J. H. St. H. Mawdsley, each of whom may retain office while holding 150 shares; any holder of 150 ordinary shares may appoint a director; remuneration, 10 per cent. of the net profits, divisible. Registered office, 10, Serjeants Inn, E.C.

Copper Co., Ltd. (79,546.)—This company was registered on December 23rd, with a capital of £100,000 in £1 shares (30,000 15 per cent. cumulative preference), to acquire certain British, Colonial and foreign patents granted or to be granted in respect of inventions relating to improvements in the electro-deposition of metals for the manufacture of compound wire bars and the like, and in apparatus therefor, with a view thereto to enter into an agreement between F. H. Medhurst of the one part, and the company of the other part, and to carry on the business of manufacturers of compound wire bars and the like, and of apparatus therefor, and any other business which is usually or may be conveniently carried on in connection with the same. The first subscribers (each with one preference share) are:—H. Francis, 42, Theobald's Road, W.C., solicitor; G. Graham, 25, Meredith Road, Barnes, engineer; J. Cheal, 141, Ilderton Road, S.E., clerk; W. Henderson, 66, Broxash Road, Clapham Common, S.W., electrical engineer; E. F. G. Truefit, 42, Theobalds Road, W.C., solicitor; C. D. McMillin, 35, Great James' Street, W.C., solicitor; and W. C. Williams, 16, Worsley Road, N.W., solicitor. No initial public issue. The number of directors is not to be less than 2 nor more than 7; the subscribers are to be appointed the first; qualification, £1,000; remuneration, £200 each per annum (£100 extra for the chairman), and 5 per cent. of the profits remaining after 15 per cent. dividend has been paid on the preference and ordinary shares, divisible. Registered Office, 13, Victoria Street, Westminster.

Ramsgate and District Electric Supply Co., Ltd. (79,516).—This company was registered on December 21st, with a capital of £30,000 in £5 shares, to carry on the business of electrical, mechanical and chemical engineers, electricians, practical engineers and contractors, manufacturers of electrical apparatus, producers of light, heat, sound and power by electricity, galvanism and magnetism, &c. The first subscribers (each with one share) are:—F. E. Grippers, Broad Sanctuary Chambers, Westminster, engineer; W. T. Pressland, Broad Sanctuary Chambers, Westminster, electrical engineer; J. C. Wigham, Coanwood, Cranes Park Avenue, Surbiton, engineer; A. J. Fippard, Broad Sanctuary Chambers, Westminster, electrical engineer; C. H. Jones, "Woodville," Queen Anne Avenue, Bromley, accountant; A. Anderson, 54, Altenburg Gardens, Clapham Common, S.W., engineer; and W. T. Belf, 32, Ampthill Square, N.W., engineer. The number of directors is not to be less than 3 nor more than 6; the subscribers are to appoint the first; qualification, £100; remuneration as fixed by the company.

ELECTRIC TRAMWAY ACCOUNTS.

Bradford and Sheffield Municipal Tramways.

THESE two Yorkshire municipal tramway enterprises have both given excellent account of themselves during the past year. In both cases a transformation to electrical working has recently taken place, and under enterprising management their route mileages have been greatly extended.

The Bradford tramways system, as will be seen, is of greater extent than that of Sheffield, and at the same time serves a smaller population.

Both systems contain many severe gradients; in the case of Bradford, power is purchased from the electric lighting department, while the Sheffield tramways department possesses its own power plant, and in addition builds most of the rolling stock in its own car works.

Mr. C. J. Spencer, the general manager, is to be congratulated on the excellent position of the Bradford system, and he is now associated with Mr. A. Blackman, who was recently appointed city electrical and tramways engineer.

In the case of Sheffield, Mr. A. L. C. Fell was tramways manager and engineer during the period under review. He having now taken up the position of general manager of the tramways under the London County Council, will be succeeded by Mr. A. R. Fearnley, under whose management the Birkenhead tramways system has made such marked progress.

GENERAL STATEMENT.

—	Bradford.	Sheffield.
For 12 months ending	March 31, 1903	March 25, 1903
Length of route	40	30
Total length of track	68	58
Number of cars in use	(Total) 200	(Av.) 143·85
Car-miles run	4,013,191	4,777,146
Passengers carried per annum ...	41,000,000	54,946,915
Capital expended to date	£750,000	£953,572
Traffic receipts	£170,115	£206,729
Total receipts	£173 534	£208,963
Working expenses	£117,496	£129,916
Gross profit	£56,038	£79,047
Income per car-mile	10·37d.	10 49d.
Working expenses per car-mile ...	7·02d.	6 53d.
Interest & sinking fund per car-mile	2·16d.	2·21d.
Sundry	—	·12d.
Total expenses per car-mile... ...	9·18d.	8·86d.
Profit or loss per car-mile	1·19d.	1·63d.
Cost of energy per car-mile	1·61d.	·71d.
Average fare per passenger... ...	1d.	·90d.
Revenue per mile of route	£4,338	£6,965
Expenditure per mile of route ...	£2,937	£4,330
Total number of units used	6,067,387	7,369,539
Units used per car-mile	1·5	1·5

It is interesting to note that the earnings per car-mile are very similar in both cases; for Bradford with its extended system the result is a very good one, and at Sheffield the figure has, no doubt, been reduced by the greater car-mileage run, and more frequent services. The units used per car-mile are much higher than the average, as a natural consequence of the hilly nature of the routes.

ANALYSIS OF WORKING EXPENSES.

Year ending, 1903.	Bradford. Gross.	Bradford. Per car-mile.	Sheffield. Gross.	Sheffield. Per car-mile.
Traffic expenses, including wages of employés, car-shed expenses, tickets and uniforms	(approx.) £43,305	2·60d.	£86,513	4·35d.
Electrical energy ...	26,932	1·61d.	14,081	·71d.
Management & general expenses, including salaries, printing, stationery, insurance, law and sundry	(approx.) 6,087	·36d.	6,440	·32d.
Rent, rates and taxes ...	6,524	39d.	6,065	·30d.
Rent of lines, Saltaire and Shipley	2,129	·13d.	—	—
Repairs and Maintenance.				
Track	5,759	·34d.	3,404	·18d.
Overhead equipment ...	1,804	·10d.	4,864	·24d.
Cars, tools, &c.	24,956	1·49d.	7,929	·40d.
Buildings, power equipment	—	—	620	·03d.
Total working expenses	£117,496	7·02d.	£129,916	6·53d.
Percentage of working expenses to receipts, 1903	67·5 per cent.		62 per cent.	

The working expenses at both towns are somewhat above the normal, as might be expected from the working conditions prevailing. Sheffield, with its own power plant, has a considerable advantage in the item for energy per car-mile, although in order to compare with the Bradford figure (for purchased energy) an allowance for financial charges on the power station and plant must be added, this, of course, being included in the Sheffield profit statement, and omitted in the case of Bradford.

PROFIT STATEMENT.

	Bradford.	Sheffield.
To interest on loans	£36,188	£27,810
To sinking fund		16,125
To depreciation and renewals from revenue	—	2,378
To balance carried down	19,850	28,168
Less interest brought forward from 1902 ...	—	—146
To deficit on horse section, closed November, 1902	—	4,712
Gross profit on year's working ...	£56,038	£79,047

On the year's working the Bradford tramways department earned a gross profit of £56,038; from this interest and sinking fund absorbed £36,188, and a balance of £19,850 was carried forward for the Committee to deal with. The Sheffield department, out of its handsome gross profit, provides for financial charges; a sum of £2,378 (provided out of revenue) for depreciation and equipment renewals; the deficit from the horse section, closed in November, 1902, absorbs £4,712, and, deducting a small item of accumulated interest, we get a balance on the year's working of £28,168.

The total accumulated surplus of this and previous years amounted to £106,956, and out of this it was proposed to grant sums as follows:—Relief of rates, £13,980! School of Modern Languages, £100!! music in parks, £250!!! (thrice lucky Sheffield); contingencies, £10,000, and renewals fund, £20,000, leaving a balance of £62,626.

With the latter items no one can find fault, and we heartily commend the "second thoughts" of the Committee in their recommendation for a renewal fund, which is based on a sum equivalent to 1d. per car-mile run, as also the Committee's opinion that the surplus should be used primarily for the benefit of the tramways undertaking.

CITY NOTES.

The British Westinghouse Electric and Manufacturing Co.

IN our "City Notes" last week we printed the report of this company, which, as we remarked in our "Stocks and Shares" column, failed to evoke any enthusiasm in the market because of the heavy new issue foreshadowed. For some little time past there have been comments in the general press regarding the delay in issuing the report, and fears have been expressed that the preference dividend might not be forthcoming. This anxiety has been set at rest by the issue of the report, but as this contains a notification of further issue of capital, and gives no date for the shareholders' meeting, it will probably not be regarded as entirely satisfactory. The profit and loss account is not a very detailed document, but it may be urged, not without reason, that for a manufacturing company excessive detail is not desirable. The "profit for the year" is £107,609 7s. 6d., "including special discounts on apparatus purchased for re-sale from the American companies, and estimated profit accrued to date on contracts in progress." Against the profit are set additional expenditure on contracts closed in the previous year £7,812 9s. 9d., experimental expenses £5,016 19s. 4d., the debenture and loan interest and preference dividend payments leaving a balance of £47,106 8s. 1d. as net profit. Of this sum only £1,144 15s. 1d. is carried to reserve, the balance being required for payment of final preference dividend.

The balance-sheet shows that patents and goodwill are valued at £793,614 2s. 2d. somewhat in excess of the ordinary share capital—£750,000. The works and machinery at Trafford Park, together with the office furniture, stand at £1,817,786 0s. 3d., whilst the preference share capital is £1,748,065 10s. Bills receivable, sundry debtors and balance due on work in progress amount together to £433,327 6s. 5d. Adding to this cash in hand £122,699 12s. 2d. gives a total of £556,026 18s. 7d., which is somewhat in excess of sundry creditors £540,839 1s. Debenture stock, temporary loan and premium on preference shares, amount to £785,423 4s. 9d., against which may be set stock and material on hand and in process of manufacture, and shares in other companies, £691,823 11s. 5d. Sundry small items of £2,040 4s. 3d. in liabilities, and £14,223 15s. 8d. in assets, with the amount brought forward from the profit and loss account, complete the particulars of the balance-sheet.

The amount of the "special discounts allowed by the American companies on orders executed at Pittsburg" is stated in the report to be "about £60,000." The amount of preference dividend paid during the year was £60,416 13s. 4d., so that if it had not been "felt by the American companies that these discounts should be made," the preference dividend would not have been secured.

Attention is drawn in the report to the value of the orders obtained, which grew from £738,000 in 1901 to £1,657,114 in 1903. This is a gratifying increase, and it may be hoped that the increase will continue so as to keep the finely-equipped factory of the company fully occupied; but the directors will, of course, bear in mind that it is the profit resulting from the orders rather than the total of the orders themselves in which investors are mainly interested.

New General Traction Co.

A GENERAL meeting of the mortgage debenture-holders of this company was held on Tuesday last week at Salisbury House, London Wall, the Hon. Arthur Brand presiding.

The CHAIRMAN proposed the following resolution:—

That this meeting of holders of the mortgage debentures of the New General Traction Co., Ltd., secured by trust deed (hereinafter referred to as "the said trust deed") dated June 28th, 1901, and made between the company of the one part and Francis Pavy, Esq., and Baron Emile B. D'Erlanger as trustees (hereinafter referred to as "the said trustees") of the other part (which meeting has been duly convened pursuant to the provisions contained in the third schedule to the said trust deed), hereby authorises the company to create and issue prior lien debentures to a total amount not exceeding £80,000, bearing interest at the rate of 4 per cent. per annum, and redeemable at the option of the company in whole or in part at any time on six months' notice, at the price of £103 for every £100, and repayable by the company paying to the trustees on January 1st, 1910, and on January 1st in every succeeding year, the sum of £4,000, to be applied in redeeming the said debentures at par in accordance with drawings such debentures to contain a floating charge on all the undertaking, property and assets, present and future, of the company, and to be secured by a trust deed containing a specific charge on the shares mentioned or referred to in the second schedule to the said trust deed; and on 500 bonds $1,000 each in the Philadelphia, Morton and Swarthmore Street Railway Co., and 180 bonds of $1,000 each in the Media, Middleton, Aston and Chester Electric Railway Co., and a floating charge on the general assets mentioned in the said trust deed; such specific charge and floating charges respectively to rank in all respects in priority to the charges created by the existing mortgage debentures of the company and the aforesaid trust deed; the trust deed securing such prior lien debentures to be in the terms of the draft which has been submitted to this meeting, and has for the purpose of identification been subscribed by the chairman hereof, with such modifications (if any) as the said trustees may consider reasonable or necessary for the purpose of giving effect to this resolution. And this meeting hereby authorises and directs the said trustees to execute and concur with the company and all other necessary parties (if any) in executing a trust deed in the form of the said draft, with such modifications (if any) as aforesaid, and to execute and do all such other deeds, acts and things as they may consider necessary or reasonable for giving effect to this resolution.

He said the shareholders would remember that at the meeting last July Baron D'Erlanger stated that for the purposes of the Coventry extension and for other demands for the current year a further sum of £40,000 would be required, and he hoped that before that money would be actually needed, they would be able to sell a sufficient number of the bonds of the Philadelphia line. Unfortunately, however, that had not been the case. They had had considerable difficulties in Philadelphia, and although they won their case in the two lower Courts, they lost in the Supreme Court. That had considerably delayed their operations, and it was only now that the line was being connected up, and they expected it would be in full working order by May of next year. That delay had involved the company in severe financial straits, and it had been necessary to review the position and see the best that could be done, and after very careful deliberation the directors had come to the conclusion that the proposal they now made was in the best interests of all concerned. He was perfectly well aware that certain securities were set aside for the security of the first debenture-holders—the Coventry, Norwich and Douglas shares—and although those shares were to be placed to the credit of

the new prior lien bonds, in addition they were to have the bonds of the Philadelphia line placed to their credit, so that really the security of the existing debenture-holders was not taken away. No doubt there was a good deal to be said against the present proposal by the present holders of debentures, but he was glad to say that for the most part they were in a few hands, and those gentlemen agreed with the board that their proposal was the best thing to be done under the circumstances. It was with deep regret that the board proposed the resolution, but they did so in the best interests of the company, and they believed that in a year or two's time, when the Philadelphia line was opened they would come with a very different story to that which he had to tell them that day.

Mr. F. FITZGERALD seconded the resolution.

Sir ALFRED HICKMAN said he wished to enter a most emphatic protest against the proposal. The prospectus, which invited subscriptions for the first debenture issue, did not contain one single word or syllable of suggestion that by any possibility the persons who subscribed could be placed in the position where the securities specially allocated to them could be put aside. The trustees who ought to have looked after their interests now came down with an overwhelming voting power in favour of the present proposal, which was all in their favour, and it was they who were going to take these prior lien debentures. He supposed that the directors were acting in accordance with the law, but there was such a thing as fairness and honesty, which should be observed by directors.

Mr. MACRAE said it was hardly correct to say that the trustees for the first debenture-holders were those who would take the new debentures; the only person to whom that remark could apply was Baron D'Erlanger. The question for the debenture-holders to settle was whether they would allow the company to be broken up and endeavour in the scramble to see whether they could secure enough to pay their debentures, or whether they would take the best course to obtain the money that was wanted to save the concern. He had great faith in the future of the company, but this money must be raised immediately, and the proposal of the directors seemed to him to be the best way to meet the difficulty.

After further discussion the resolution was carried.

Official Announcements re Companies.

THE following companies have been struck off the register and dissolved:—

Brianne Electric Lamp Co., Ltd.
Economic Steam Producer Syndicate, Ltd.
Electrical Guarantee and Trust, Ltd.
Electrical Undertakings, Ltd.
Electric Propulsion, Ltd.
Electro-Ceramic Syndicate, Ltd.
Ferrolite Electric Syndicate, Ltd.
Fylde Painting, Plumbing and Electric Engineering Co., Ltd.
Herne Bay and Canterbury Light Railway Syndicate, Ltd.
Hire Purchase Electric Wiring Co., Ltd.
Lancashire and Grand Trunk Electric Tramways, Ltd.
Lancashire United Electric Tramways, Ltd.
London Electrical Cab Co., Ltd.
Reading and District Motor Car Co., Ltd.
Road and Tramcar Electric Traction Co., Ltd.
Russian Peat-Briquettes Co., Ltd.
Ryde Electric Light and Power Co., Ltd.
Silent Smoke Consumer, Ltd.
Smoke Prevention and Engineering Syndicate, Ltd.
Statters (Birmingham), Ltd.
Uxbridge and Rickmansworth Railway Syndicate, Ltd.

Edmundson's Electricity Corporation, Ltd.—The directors have declared an interim dividend of 5 per cent. per annum on the ordinary shares (payable on January 15th) for the half year ended September 30th, 1903.

Stock Exchange Notice.—Applications have been made to the Committee to allow the following to be quoted in the Official List:—Consolidated Electrical Co., Ltd.—109,251 ordinary shares of £1 each, Nos. 1 to 109,251.

STOCKS AND SHARES.

Wednesday Evening.

WITH the year closing under the shadow of the Russo-Japanese trouble, which paralyses business and makes stocks more easy to buy than to sell, the disappointing 1903 comes to an unwept end. Business in the Stock Exchange has been bad: only a member can tell how bad, but there is some consolation derivable from the comparative ease of money, and the freedom from the financial difficulties usually associated with the last days of most Decembers. In the markets with which we deal, the Telegraph section has shown itself the fittest so far as survival of quotations is concerned, but in this connection it has to be borne in mind that prices a year ago were very flat in consequence of the Marconi bogey.

Taking the electricity supply department first in a fleeting review of the year's prices, it will be noticed that the changes on the twelvemonth are chiefly remarkable for their insignificance, if the paradox is permissible. A good deal of the improvement recorded for the first six months of the year has since been lost, so that now the widest margin of fluctuation is but 30s. a share, which is shown by Metropolitans and Notting Hills with a rise and fall respectively. Here is a short table:—

Company.	Jan. 2, 1903.	Dec. 30, 1903.	Rise or Fall.
Brompton and Kensington..	10½	10½	¼
Charing Cross	9½	9	½
Chelsea	5¾	5¾	¼
City of London	10¾	10¾	—
Edmundson's	6¾	6¼	½
Metropolitan	16	17½	1½
Notting Hill	14½	13	1½
St. James's	15	15	—
Smithfield	2¼	3¼	1
Westminster	11½	12½	1

Of these shares, speculative attention has been mainly devoted to Metropolitans, the various phases of the Marylebone conflict causing considerable fluctuation. After being as high as 20—touched when the announcement of the award was made—and as low as 16 this year, the price leaves off at 17½. Other supply shares fail to reflect in their quotations the present outlook for generally advanced dividends, but like all other investment securities, they are being more affected by extrinsic causes than intrinsic merits.

Melancholy is the story which has to be told to proprietors of electric railway stocks. The severe slump in City and South London Ordinary has reduced the price of the stock 27½ points since the twelvemonth began. Moreover, at one time City Ordinary reached 80 during the year, and it is closing at practically the lowest level, thanks to the declining traffics due to County Council tramway competition, and the scare consequent upon the Paris disaster. Nor has Central London stock escaped the general epidemic of flatness that has shaken home railways so violently this year, the sentimental malinfluence being reinforced by much more practical fears as to how the line may suffer upon the electrification of the Metropolitan and the District Cos. Comparative prices can be studied in this list:—

Stock.	Jan. 2, 1903.	Dec. 30, 1903.	Fall.
Central London Ordinary ..	108½	94½	14
,, ,, Deferred ..	109½	94½	15
City & South London	76	48½	27½
Waterloo and City	95½	92½	3
Metropolitan Consolidated ..	91½	86	5½
Metropolitan District	38½	34	4½

Until quite recently Waterloo and City stock had a rise to show, but this disappeared before the latest fall was brought about by sympathetic flatness with London and South-Western stocks, knocked down by an inopportune offer of capital. Metropolitan has varied between 94½ and 80, while Districts have 43¾ and 32 for their limits during the year.

Electric traction issues have moved irregularly. British Electrics on January 2nd were 12⅜, rose to 14⅓, and end the year badly at 11⅓. London United Tramways Preference finished, as they commenced, at 11⅓. Several of the Argentine tramway properties have advanced upon the attention claimed by the Silver Republic on the score of its prosperity, but taking it all round, the tramway market has had a somewhat uneventful year, in spite of ever-increasing attention directed to electric traction.

Even as children love to keep a *bonne bouche* for the final mouthful, so we reserve for our customary third table that which relates to the telegraph market, where alone a note of cheerfulness is to be found. A few representative examples suffice to show the general tone:—

Stock or share.	Jan. 2, 1903.	Dec. 30, 1903.	Rise or Fall.
Anglo-American Preferred ..	90	93	3
Ditto Deferred	8⅛	8	⅛
Eastern Telegraph	117½	123½	6
Eastern Extension	10⅝	11⅜	¾
Great Northern Telegraph ..	25⅛	25⅛	—
Western Telegraph	11½	12	½
Reuter's	7	7	—

Good yields, coupled with returning confidence of the companies' ability to hold their own against wireless wonders have contributed to this more satisfactory result, besides which, as we have already mentioned, prices started from a fairly depressed line at the beginning of the year. The Telegraph department has been very free on the whole from scares during 1903, and business remained all through of the solid investment type. Some of the shares in this section are being quietly absorbed by the Continent, chiefly by Parisian purchasers. Miscellaneous shares have spent an uneventful period. Taking Henleys as one instance, the price has been 17 and now is 14, the lowest of the year, and Callenders are 11½ after rising to 14⅜. In each case the decline may be traced to the general dulness of nearly all the investment markets round the Stock Exchange. National Telephone Preferred at 102 has risen 7 per cent., and the Deferred stock, standing at 78½, compares with 68 on January 2nd. The latter has been as good as 89⅜ during the year.

Prospects for 1904 certainly open none too cheerfully, and much boldness would be wanted to prophesy an immediate improvement in Stock Exchange values. A great deal depends upon the news from the Far East, but brushing aside influences that can only be transitory, it is obvious that the markets display an unusual range of cheap shares, of which the public will undoubtedly take advantage in the course of time. The low levels at which so many quotations now stand, are, in themselves, an encouragement of hope for better business when 1904 gets into the swing of restored confidence and settlement of trade.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations Dec. 21st.	Closing Quotations Dec. 30th.	Business done week ended Dec. 30th, 1903. Highest	Lowest
£7,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	99 —103	99 —103	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2⅛ — 8¼	2⅛ — 8¼	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	70 — 80	70 — 80	..	..
788,840	Anglo-American Telegraph	Stock	3⅛%	61s.	60/6	49 — 52	49 — 52	..	..
3,105,680	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	92 — 94	92 — 94	93¼	93⅛
3,105,680	Do. do. do. Deferred	Stock	5s. %	2s.	1/-	7⅞ — 8⅛	7⅞ — 8⅛	7⅞	7⅞
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	5 %	6 %	4⅛ — 5¼	4⅛ — 5¼	..	..
18,383,300$	Commercial Cable	$100	8 %	8 %	8 %	145 —155	160 —170 xd	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	90 — 93	88 — 92 xd	..	..
16,000	Cuba Telegraph	10	4½%	4 %	6¾%	7 — 8	7 — 8	..	..
6,000	Do. 10 % Pref.	10	..	..	..	16 — 17	16 — 17	..	..
12,981	Direct Spanish Telegraph	5	4 %	4 %	4 %	2⅛ — 3¼	2⅛ — 3¼	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7 — 8	7 — 8	7⅞	7
30,000	Do. do. 4½ % Debs.	50	..	..	..	97 —101	100 —103 %	101⅛	101
60,710£	Direct United States Cable	20	3½%	3½%	3½%	10 — 10¾	10 — 10⅞	10⅛	..
87,800	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	99 —102	100 —103	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	122 —127	121 —126	..	..
1,955,565	Do. 3½ % Pref. Stock	100	..	..	..	85 — 88	86 — 89	..	..
1,534,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	105 —108	105 —108	..	..
800,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	11 — 11⅛	11 — 11¼	11⅜	11⅛
820,000£	Do. 4 % Deb. Stock	Stock	..	..	..	106 —109	105 —109	..	..
800,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 8,000, red. 1909	100	..	..	..	99 —102	99 —102	..	..
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	99 —102	99 —102	100⅜	100
180,227	Globe Telegraph and Trust	10	5½%	5½%	..	8⅛ — 8¾	8⅛ — 8¾	..	..
180,042	Do. do. 6 % Pref.	10	..	..	..	12⅛ — 13	12⅛ — 13	12⅝	..
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	15 %	12½%	25 — 26	25 — 26	..	..
62,500£	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	99 —102	100 —103	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	10%	37 — 40	37 — 40	38½	..
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	..	..	..	98 —102	98 —102	..	..
1,988,333	National Telephone, Pref. Stock	100	5 %	5 %	6 %	101 —103	101 —103	103	102
1,966,667	Do. do. Def. Stock	100	..	..	4½%	76 — 79	77 — 80	78½	78
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 14	13 — 14	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	13 — 14	13 — 14	..	..
2,250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅛ — 5⅝	5⅛ — 5⅝	..	..
000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	96 — 98	94 — 96 xd	..	..
600,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	102 —104	100 —102 xd	10⅛	..
179,313	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	6 %	⅞—1	⅞— 1	..	..
50,000	Do. do. do. 6 % Cum. Pref.	1	..	..	..	.. — ..	1 — 1⅛	..	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	97 —100	98 —101	..	..
11,839	Reuter's	8	5 %	5 %	..	6½ — 7⅞	6½ — 7⅞	..	..
8,808	Submarine Cables Trust	Cert.	..	..	..	116 —121	117 —122	..	..
58,000	United River Plate Telephone	5	7 %	7 %	7 %	5½ — 6	5½ — 6 xd	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4½ — 5½	4½ — 5½ xd	..	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	104 —107	102 —105 xd	..	..
15,609	West African Telegraph, Shares	10	..	..	2 %	5 — 6	5 — 6	..	..
150,000£	West Coast of America, 4% Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	..	..	..	95 — 98	96 — 99	..	..
267,980	Western Telegraph, Ltd., Nos. 1 to 267,980	10	7 %	7 %	7 %	11¾ — 12¼	11¾ — 12¼ xd	1	..
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	100 —103	101 —104	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	99 —102	98 —101	..	..
88,321	West India and Panama Telegraph	10	1¼%	..	..	⅜ — ½	⅜ — ½	..	..
34,568	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	6 — 6½	6 — 6½	..	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	4½ — 5½	4½ — 5½	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,600	100	..	..	..	101 —104	101 —104	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	4½ — 5½	4½ — 5½	..	..
800,000£	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	..	..	..	88 — 92	88 — 92	..	..
100,000	British Electric Traction	10	9 %	9 %	8 %	11½ — 12¼ xd	11½ — 12 xd	11⅝	..
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	11⅜ — 11⅝	11⅜ — 11⅝	11⅝	11⅜
800,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	120 —123	120 —123	..	..
100,000	British Insulated and Helsby Cables	5	15 %	10 %	10 %	6 — 6½	6 — 6½	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5½ — 5⅞	5½ — 5⅞	..	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	103 —108	102 —107 xd	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	8 %	Nil	..	7/6 — 11/6	7/6 — 11/6	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	6 %	..	14/6 to 15/6	14/6 to 15/6	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	5 %	Nil	Nil	¾ — 1¼	¾ — 1¼	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	8 %	6 %	1¼ — 1½	1¼ — 1½	..	..
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	97 —100	97 —100	..	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	73 — 85	75 — 80 xd	..	..
25,000	Callender's Cable Construction shares	5	15 %	20 %	15 %	11 — 12	11 — 12	11⅛	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5¼ — 5¾	5¼ — 5¾ xd	..	..
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	106 —110	104 —108 xd	..	..
1,860,014	Central London Railway, Ord. Stock	Stock	..	4 %	4 %	93 — 96	93 — 96	96	94
494,098	Do. do. 4 % Pref. Stock	Stock	..	4 %	4 %	99 —102	99 —102	..	..
494,998	Do. do. Def. do.	Stock	..	4 %	4 %	95 — 98	93 — 96	..	..
1,330,000	City and South London Railway	Stock	1½%	2 %	3½%	47 — 50	47 — 50	50	49
85,000	Crompton & Co., Nos. 1 to 85,000	3	8 %	7½%	5 %	1⅞ — 2⅛	1⅞ — 2⅛	..	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	99 —103	99 —103	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	2½%	Nil	..	0 — ¼	0 — ¼	..	..
17,139	Do. do. "A" shares, 01—017,139	5	2½%	Nil	..	¼ — 1⅛	¼ — 1⅛	..	..
344,023£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	72 — 77	71 — 76 xd	..	..
100,000£	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	..	..	..	76 — 81	76 — 81	..	..
119,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	1¼ — 1⅜	1⅛ — 1⅜	..	..
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	2	..	..	..	2¼ — 3	2¼ — 3	..	..
82,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	97 —100	98 —101	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	5 %	9¾ — 10¼	9¾ — 10¼	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	96 — 99	96 — 99	..	..
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	20 %	14 — 15	13½ — 14½	14	..
35,000	Do. do. 4½ % Pref.	5	4½%	..	..	5 — 5⅛	5 — 5⅛	..	..
48,050	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	108 —112	108 —112	..	..
60,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	10 %	19 — 20	18 — 19 xd	..	..
800,000£	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	100 —103	100 —103	..	..
97,500	†Liverpool Overhead Railway, Ord.	10	3½%	1½%	1½%	4⅜ — 5	5⅛ — 5⅜	..	..
10,000	† Do. do. Pref. £10 paid	10	..	..	..	10¼ — 10⅜	10¼ — 10⅜	..	..
97,350	Telegraph Construction and Maintenance	12	17½%	20 %	20 %	34 — 37	34 — 37	..	..
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	101 —104	102 —105	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3 %	3½%	91 — 94	91 — 94	..	..

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List.

Bank rate of discount 4 per cent. (September 3rd, 1903).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations Dec. 21st.	Closing Quotations Dec. 30th.	Business done week ended Dec. 30th, 1903. Highest.	Lowest.
100,000	Blackheath and Greenwich Dist. Electric Light, Ord...	‡ 1	..	..	..	5/8 — 7/8	5/8 — 7/8	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs. ..	100	..	..	..	114 —117	114 —117	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	5	6 %	8 %	8 %	10¼ — 10⅜	10¼ — 10⅜	..	..
20,000	Do. do. 7 % Cum. Pref. ..	5	..	..	..	9½ — 9⅝	9⅜ — 10⅛	..	..
50,000	Charing Cross and Strand Electricity Supply	5	9 %	10 %	10 %	.. — ..	8⅜ — 9⅛	9⅛	9⅛
70,000	Do. do. do. 4½% Cum. Pref. ..	5	..	..	..	5⅜ — 5⅝	5⅜ — 5⅝	5⅜	..
40,000	Do. do. "City Undertaking" 4½% Cum. Pref. ..	5	..	..	..	4⅜ — 5	4⅜ — 5	..	..
250,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	103 —105 xd	103 —105	..	..
44,436	*Chelsea Electricity Supply, Ord.	5	5½%	4 %	4¼%	5⅛ — 6	5⅛ — 6	..	..
150,000	Do. do. % Deb. Stock Red.	Stock	..	..	..	107 —110	105 —108 xd	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595 ..	10	0 %	5 %	5 %	10 — 10½	10⅛ — 11	10⅛	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	..	..	13 — 14	13 — 14	..	..
400,000‡	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	..	..	..	122 —127	121 —126 xd	..	..
800,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	..	..	..	102 —105	101 —104 xd	..	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000..	10	4 %	4 %	4 %	7⅞ — 8⅛	7⅞ — 8⅛	8⅛	..
20,000	Do. do. do. 6 % Pref., 40,001—60,000..	10	..	..	..	11⅝ — 12⅛	11⅝ — 12⅛	..	..
400,000‡	Do. do. 4½% Deb. Stock	..	..	..	..	108 —111	106 —109 xd	..	..
250,000	Do. do. 4½% 2nd Deb. Stock	Stock	..	..	..	100 —100½	99 —102	..	..
50,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	7 %	6 — 6⅛	6 — 6⅛	6⅛	..
30,000	Do. do. 6 % Cum. Pref.	..	..	..	..	6 — 6⅛	6 — 6⅛	..	..
140,000	Do. do. 4½% 1st Mort. Deb. Stock ..	100	..	..	..	104 —107	104 —107	..	..
21,000	Kensington and Knightsbridge Electric, Ord.	5	12 %	10 %	10 %	10½ — 11½	10½ — 11½	..	..
90,000	Do. do. do. 4 % Debenture Stock ..	Stock	..	..	..	101 —104	101 —104	103	..
110,000	London Electric Supply Corporation, Limited, Ord.	3	..	..	..	1⅞ — 2⅛	1⅞ — 2⅛	..	..
49,840	Do. do. do. 6 % Pref.	5	..	..	..	5 — 5⅛	5 — 5⅛	..	..
250,000‡	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	..	..	..	97 —100 xd	97 —100	..	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	6 %	6¾%	7½%	17 — 18	17 — 18	17⅞	..
71,106	Do. do. 4½% Cum. Pref. 1—71,106, £3 paid ..	5	..	..	..	4⅛ — 4⅜	5⅛ — 5⅜	4⅛	..
250,000‡	Do. do. 4½% 1st Mort. Deb. Stock ..	..	..	..	..	110 —114	109 —113 xd	..	..
250,000‡	Do. do. 3½% Mort. Deb. Stock Red	Stock	..	..	..	96 — 99	95 — 98 xd	95⅛	..
10,852	Notting Hill Electric Lighting	10	7 %	6 %	6 %	12½ — 13½	12⅝ — 13½	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14½ — 15⅝	14⅝ — 15⅝	..	..
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	..	..	..	7⅜ — 8½	7⅜ — 8⅝	..	..
150,000‡	Do. do. do. 3½% Deb. Stock Red ..	100	..	..	..	98 —101	97 —101 xd	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	..	..	2½%	3 — 3½	3 — *3½	..	..
50,000	Do. do. do. 4 % Deb. Stock	Stock	..	..	..	— —	85 — 90	86¼	86
65,000	South London Electricity Supply, Ord.	5	..	..	12½%	3⅛ — 3⅜	3⅛ — 3⅜	3⅜	3⅜
80,000	Urban Electric Supply, Ord.	5	..	..	..	4⅜ — 5⅛	4⅜ — 5⅛	..	..
80,000	Do. do. 5 % Cum. Pref.	5	..	..	..	4⅜ — 5⅛	4⅜ — 5⅛	..	..
110,000	Westminster Electric Supply, Ord.	5	10½%	10½%	12 %	12 — 13	12 — 13	..	..
28,141	Do. do. 5 % Cum. Pref.	5	..	..	..	6 — 6½	6 — 6½	..	..

* Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Wednesday, December 30th.

CHEMICALS, &c.		Latest Price.	Week's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a ,, Nitric	per cwt.	22/-	..
a ,, Oxalic	per cwt.	32/-	..
a ,, Sulphuric	per cwt.	5/6	..
a Ammoniac, Sal	per cwt.	42/-	..
a Ammonia, Muriate (crystal) ..	per ton	£38 10	..
a ,, ,, ...	per ton	£30	..
a Bleaching powder	per ton	£4 10	..
a Bisulphide of Carbon	per ton	£15	..
a Borax	per ton	£13	..
a Benzole (90 %)	per gal.	7/-	..
a ,, (50/90 %)	per gal.	5/6	..
a Copper Sulphate	per ton	£20	..
a Lead, Nitrate	per ton	£24	..
a ,, White Sugar	per ton	£31	..
a ,, Peroxide	per ton	£27 10	..
a Methylated Spirit	per gal.	2/6	..
a Naphtha, Solvent (90% a 160° C).	per gal.	5/6	..
a Potash, Bichromate, in casks ..	per lb.	8d.	..
a ,, Caustic (75/80%).. ..	per ton	£24	..
a ,, Bisulphate	per ton	£35	..
a Shellac	per cwt.	236/-	..
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 10	..
a ,, Recovered	per ton	£5 10	..
a ,, Lump	per ton	£5	..
a Soda. Caustic (white 70 %) ..	per ton	£10 15	..
a ,, Crystals	per ton	£8	..
a ,, Bichromate, casks.. ..	per lb.	2½d.	..
METALS, &c.			
b Aluminium Ingots, in ton lots ..	per ton	£130	..
b ,, Wire, in ton lots ..	per ton	£168	..
b ,, Sheet, in ton lots ..	per ton	£166	..
p Babbitt's metal ingots	per ton	£48 to £130	..
e Brass (rolled metal 2' to 12') basis	per lb.	6⅞d.	..
e ,, Tube (brazed)	per lb.	8¾d.	..
e ,, ,, (solid drawn).. ..	per lb.	7¼d.	..
e ,, Wire, basis..	per lb.	7d.	..
e Copper Tubes (brazed)	per lb.	9¾d.	..
e ,, ,, (solid drawn) ..	per lb.	9¼d.	..
g Copper Bars (best selected ..	per ton	£71	..

METALS, &c. (*continued*).		Latest Price.	Week's Inc. or Dec.
g Copper Sheet	per ton	£71	..
g ,, Rod	per ton	£71	..
e ,, (Electrolytic) Bars ..	per ton	£69	..
e ,, ,, Sheets ..	per ton	£78	..
e ,, ,, Rod ..	per ton	£75	..
e ,, ,, H.C. Wire	per lb.	7¾d.	..
f Ebonite Rod	per lb.	3/3	..
f ,, Sheet	per lb.	3/-	..
n German Silver Wire	per lb.	1/6	..
h Gutta-percha fine	per lb.	9/-	..
h India-rubber, Para fine	per lb.	3/10½ to 3/11	..
i Iron, Charcoal Sheets	per ton	£18	..
i ,, Pig (Cleveland warrants)	per ton	43/-	1/6 inc.
i ,, Forgings, according to size	per ton	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	..
i ,, Wire, galvanised No. 8 ..	per ton	£9 15	..
g Lead, English Ingot	per ton	£11 10 to £11 15	2/6 dec.
g ,, Sheet	per ton	£13	..
m Manganin Wire No. 28	per lb.	8/-	..
g Mercury	per bot.	£8 5	..
d Mica (in original cases) small ..	per lb.	4d. to 1/6	..
d ,, ,, medium	per lb.	2/6 to 3/9	..
d ,, ,, large ..	per lb.	4/- to 7/9	..
p Phosphor Bronze, plain castings	per lb.	1/- to 1/2½	..
p ,, rolled bars & rods	per lb.	1/- to 1/3	..
p ,, ,, strip & sheet	per lb.	From 1/1	..
o Platinum	per oz.	£4	..
p Silicium Bronze Wire	per lb.	9d. to 11d.	..
i Steel, Magnet, acc'd'g to desc'p'n	per ton	£58	..
i ,, ,, in bars		£15 to £40	..
g Tin, Block	per ton	£134 to £135	£2 inc.
g ,, Foil	per lb.	1/6	..
n ,, Wire, Nos. 1 to 16	per lb.	1/8	..
p White Anti-friction Metals— "White Ant" brand ..	per ton	£42 to £62	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	8d.	..
j ,, 6 lea. Flax	per lb.	5¾d.	..
j ,, 3 ply 10 lbs. Russian ..	per lb.	4½d.	..
j ,, 10 lbs. Russian, single ..	per lb.	4¼d.	..
j ,, 180 lbs. Jute rove ..	per ton	£11	..
k Zinc, Sh's (Vieille Montagne bnd.)	per ton	£23 15	..

Quotations supplied by Messrs.:—*a* G. Boor & Co.; *b* The British Aluminium Co., Ltd.; *c* Thos. Bolton & Sons., Ltd.; *d* F. Wiggins & Sons.; *e* Frederick Smith & Co.; *f* India-Rubber, G.P. and Teleg. Works Co., Ltd.; *g* James & Shakspeare; *h* Edward Till & Co.; *i* Bolling & Lowe; *j* Walter H. Hindley and Co., Ltd.; *k* Morris Ashby, Ltd.; *m* W. T. Glover & Co., Ltd.; *n* P. Ormiston & Sons; *o* Johnson, Matthey & Co., Ltd.; *p* The Phosphor Bronze Co., Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS

Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open.	*
Aberdeen	Dec. 26	1,175	+274	30	37,147	+ 6,560	10	—
Birmingham ..	,, 26	4,970	—156	52	263,966	+ 9,879	8½	—
Bournemouth ..	,, 23	873	—	—	—	—	10½	—
Blackburn	,, 25	1,032	+146	—	38,465	+ 1,270	18½	—
Blackpool	,, 24	287	— 18	—	37,608	— 159	8½	—
,, —Fleetw'd	,, 26	282	— 1	—	20,754	— 101	7½	—
,, —Lytham	,, 24	144	+121	8	1,144	+ 667	7½	—
Bolton	,, 27	1,884	+206	—	71,701	+ 8,495	25	—
Bradford	—	—	—	—	—	—	41	+4
Brighton	,, 27	872	— 91	—	36,281	—	7½	—
Bristol	,, 25	5,314	+ 49	—	—	—	28	—
Burnley	,, 26	1,018	+220	—	—	—	7½	—
British Elec. Trac. Co. Barnsley District	,, 18	141	— 10	50½	8,988	— 12	4½	—
British Elec. Trac. Co. Devonport	,, 18	460	+ 82	50½	21,253	+ 1,675	5	—
British Elec. Trac. Co. Dudley—Sto'rb'ge	,, 18	728	+ 33	50½	41,877	+ 3,869	18½	—
British Elec. Trac. Co. Gateshead ..	,, 18	858	+ 23	50½	44,204	+ 5,438	10½	+ ½
British Elec. Trac. Co. Gr'n'k—Pt. Glsgw	,, 18	431	+ 50	50½	27,371	+ 2,288	7½	—
British Elec. Trac. Co. Hartlepool ..	,, 18	241	+ 34	50½	13,580	+ 937	6½	+2
British Elec. Trac. Co. Middleton.. ..	,, 18	238	+ 34	50½	15,795	+ 1,925	8½	—
British Elec. Trac. Co. Oldham—Ashton	,, 18	498	+ 15	50½	28,473	+ 1,624	8	—
British Elec. Trac. Co. Peterborough ..	,, 18	106	—	47	7,311	—	—	—
British Elec. Trac. Co. Poole	,, 18	209	+ 12	50½	15,045	+ 2,147	3½	—
British Elec. Trac. Co. Potteries	,, 18	1,670	+116	50½	80,108	+ 8,756	28½	—
British Elec. Trac. Co. Southport ..	,, 18	221	+ 16	50½	15,618	+ 2,701	5½	—
British Elec. Trac. Co. South Staffs. ..	,, 18	955	+330	50½	46,391	+ 8,730	21½	— ½
British Elec. Trac. Co. Swansea	,, 18	462	+ 18	50½	26,039	+ 2,182	5½	—
British Elec. Trac. Co. Tynemouth ..	,, 18	180	— 18	50½	15,407	+ 743	3½	—
British Elec. Trac. Co. Wolverhampton..	,, 18	823	— 13	50½	19,498	+ 7,695	10½	+8
British Elec. Trac. Co. Yorks. Wool Dist.	,, 18	495	—	43½	17,064	—	6	—

* Compared with the corresponding period of 1902.

Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open.	*
B.E.T. Co.—*cont.* Miscellaneous ..	Dec. 18	631	—	—	52,243	—	—	—
Burton-on-Trent ..	,, 27	250	—	21	7,541	—	8½	—
Cardiff	,, 19	1,829	+287	—	74,808	+20,149	11	—
Chatham & District	,, 17	519	+160	50	26,990	+14,218	8·53	—
Cork	,, 24	482	— 5	51	26,286	— 3,375	9	—
Dover	,, 19	169	+ 8	—	11,064	+ 74	3	—
Dublin	,, 26	5,140	+119	—	181,009	+ 8,521	46½	+ ½
East Ham	,, 26	643	+ 57	—	26,190	+ 7,507	5	+ ½
Glasgow	,, 26	13,497	+924	—	409,720	+42,318	69½	+7½
Halifax (2 weeks) ..	,, 16	2,092	+210	37	51,276	+ 5,741	31½	+1½
Hull	,, 26	2,318	+261	39	73,554	+ 4,645	18	+2½
Ilkeston	,, 16	114	—	—	—	—	4	—
Isle of Thanet ..	,, 26	275	— 78	—	83,251	— 1,639	10½	—
Leeds	,, 26	5,625	+ 42	—	215,459	+13,051	41	—
Liverpool	,, 26	9,753	+154	51	512,053	+17,275	102	—
London C. C. ..	,, 26	9,655	+655	38	334,958	+70,261	39½	—
Manchester	,, 26	11,605	+3121	—	455,331	+259,608	72	—
Newcastle	,, 26	3,997	+584	—	—	—	17	—
Portsmouth	,, 26	1,360	— 26	—	70,011	+ 4,278	14½	—
Salford	,, 14	3,741	+959	—	141,782	+41,726	30	—
Southampton	,, 17	814	+ 17	—	—	—	16½	—
Southend-on-Sea ..	,, 16	196	+ 86	37	12,617	+ 2,036	8	—
Sunderland	,, 27	1,208	— 30	—	48,061	+ 2,190	20	+3
Wolverhampton ..	,, 27	452	— 23	—	—	—	—	—
Cen. London Rly. ..	,, 26	6,412	+277	24	166,820	— 6,782	6	—
City & S. Lon. Rly.	,, 27	2,979	—164	26	70,694	— 10,302	6½	—
Dublin—Lucan Rly.	,, 20	97	+ 11	—	3,119	+ 191	6½	—
L'pool Overh'd Rly.	,, 27	1,561	+150	—	42,912	+ 2,883	6½	—
Mersey Railway ..	,, 19	1,356	+252	25	33,245	+ 6,519	4½	—

INSTITUTION OF ELECTRICAL ENGINEERS.

THE CITY AND SOUTH LONDON RAILWAY: WORKING RESULTS OF THE THREE-WIRE SYSTEM APPLIED TO TRACTION, &c.

By PETER VALENTINE MCMAHON, Member.

(*Abstract of Paper read December 17th*, 1903.)

(*Continued from Vol. 53, page 1052.*)

THE working conductor itself is of channel steel of high conductivity. It has a cross-section of 4 sq. in., and weighs 40 lbs. per yard. It is laid in 30 ft. lengths, and is joined up with copper fish-plates, which also form the means of holding it down to the insulators. On the Islington extension the copper fish-plates were strengthened by steel plates on one side, as experience showed that the copper plates in some cases allowed the channel steel to get slightly out of truth. Under each joint or fish-plate there is a special holding-down insulator into which the copper fish-plates grip and hold the working conductor in position: the remaining insulators are simply let into the sleepers and serve as supports only for the working conductor. Fig. 6 shows the details of conductor and insulators.

Each running rail is bonded with two flexible bonds of 0·165 sq. in. section in the bottom flange of the rail. In addition the rails are cross-bonded and joined to the tunnel at regular intervals. The up and down tracks are also cross-bonded at the cross-over roads.

In order to get from one side of the system to the other, or to change from the positive to the negative side, a wooden break 30 ft. long is left in the working conductor. This length was chosen so that two locomotives coupled together could not make 1,000-volt "short." The locomotives run over these breaks by their own momentum, and as the collecting shoes are 13 ft. 9 in. apart, a break of 16 ft. 3 in. is left. This break was found to cause an appreciable flicker in the train lights, and the difficulty was overcome by screwing metal plates on each side of the wooden strip and joining them up to the conductor by a fuse, leaving the actual break only 16 ft. long. The drivers switch off the current on approaching the break, but if this precaution is neglected sometimes an arc is drawn out by the locomotive shoe, and the fuse blows before any harm is done.

In addition to the feeder cables above described, there is a complete and independent set of cables for the supply of current to the electric lifts, and also for the station lighting. The electric lifts on the Clapham extension are fed from an independent switchboard in the generating station at Stockwell by two 0·25 sq. in. cables. The lifts between Stockwell and London Bridge being hydraulic, no cables are required; but from London Bridge to the Angel (both stations included) electric lifts are installed, and are fed from both sub-stations through special panels on the switchboards.

One special lighting feeder, 0·15 sq. in. section, runs the whole length of the line in each tunnel, and supplies the station and signal lights. These cables are fed from the generating and both sub-stations as follows:—

At the generating station and the Angel sub-station the batteries in connection with the Highfield boosters have separate switchboards which are practically extensions of the bus-bars The special light feeders are joined up to these boards through a fuse and throw-over switches, so that the lighting can be maintained from the bus-bars, the battery, or the battery working in connection with the boosters. The lift cables are similarly connected, but have an automatic circuit-breaker instead of a fuse. At London Bridge sub-station ordinary non-reversible boosters are employed, and here the lighting and lift feeders are usually coupled up to the bus-bars, the former through a fuse, and the latter through an automatic circuit-breaker. Throw-over switches are also used to feed the lighting and lift system from this battery in case of necessity. As a further precaution, at each station where electric lifts are installed, throw-over switches are fixed, so that, in the event of the special lift cables breaking down, the lifts can be fed direct from the working conductor.

As already stated, there are two sub-stations, one at London Bridge and the other at the Angel, Islington.

At London Bridge, each of the four high-tension feeders is connected to its own panel on the switchboard through an emergency quick-break switch operated by hand only. Connections are then made through the automatic circuit-breakers and switches with the reducers and working conductor.

Four of the Electric Construction Co.'s continuous current reducing motor-generators are installed at this sub-station. Fig. 7 shows a longitudinal elevation of the machines. The reducers are mechanically connected in pairs, one set working on the "up" and the other on the "down" side of the system. In this manner, in addition to these machines acting as reducing motor-generators, they also serve the function of balancers. This effect can be plainly observed on the ammeters in the generator armature circuits. The current entering the motor or outside armature remains fairly steady, while that in the generator-armature varies considerably, showing that these armatures are also tending to maintain an electrical balance on the two sides of the system. It will be noticed that each machine has an auxiliary field and series winding in circuit with the feeder. This enables the machine to compensate for the variable feeder loss and to supply at all loads up to full normal load and overload, current to the working conductor at the same voltage as the generating station bus-bars.

Each machine is capable of delivering to the working conductor 300 amperes at 500 volts continuously, the speed being about 600 r.p.m., and the overload, for considerable periods, being 400 amperes. Under ordinary full normal load conditions the armature current and voltage is as follows:—

Generator between working conductor and rails, 500 volts, 130 amperes.

Motor between high-tension feeder and working conductor, 430 volts, 170 amperes.

That is to say, compensation is provided for a line drop of 70 volts at 170 amperes.

The temperature-rise after six hours' run at normal full load does not exceed 70° F., and the machine can run for a further two hours on overload without excessive heating or sparking.

Tested as a transformer, the ratio of the output on the generator side to the input on the motor side is 91·5 per cent.

The battery contains 556 49-H.B. 11-type Tudor cells divided

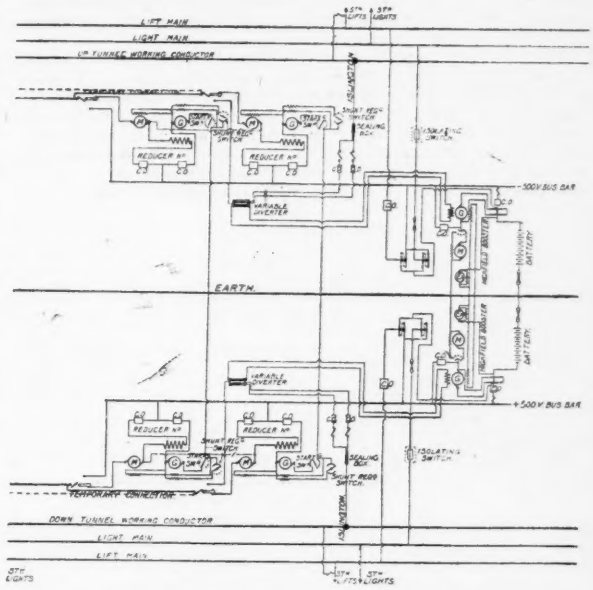


FIG. 5.—DIAGRAM OF SYSTEM. ANGEL SUB-STATION CONNECTIONS.

between the three arches, and so arranged that the cells between which there is a high difference of potential are placed in different arches. The following is the capacity of the cells:—

490 ampere-hours when discharging at 70 amperes for 7 hours.					
450	"	"	150	"	3 "
400	"	"	200	"	2 "
350	"	"	350	"	1 "

The cells are capable of standing a discharge of 500 amperes for short periods.

The 556 cells are, of course, divided up into two batteries, one on each side of the system. In each battery 32 cells are coupled up as regulators.

The boosters used in connection with the battery at this sub-station are of the ordinary E.C.C. non-reversible type. The motor

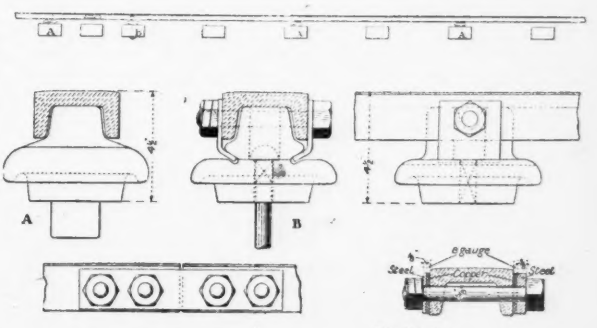


FIG. 6.—DETAILS OF WORKING CONDUCTORS AND INSULATORS.

side of each booster is shunt-wound, and capable of working at any E.M.F. between 480 and 510 volts. The generator side delivers up to 150 amperes at 200 volts. The machines run at 600 revolutions per minute, and have a commercial efficiency of 85 per cent. at full load. The battery is usually charged during the periods of light load or other times convenient to the generating station. It is practically kept in reserve as regards supplying current to the working conductor, but is used to supply the light and lift cables, and for lighting at night when all the generating plant is shut down. When used on the bus-bars to supply current to the working con-

ductor, the regulating cells are brought into use, the bus-bar voltage being too steady to allow the battery to charge or discharge on the line. It will, of course, take heavy peaks under these conditions, but then the voltage drop must be perceptible. The behaviour of the battery at this and the Angel sub-stations shows in a marked degree the advantage of a reversible booster.

The Angel sub-station (fig. 5) differs slightly from that just described.

The reducers are exact duplicates of those at London Bridge, with the field-winding slightly altered to compensate for the higher cable loss. Although two complete lines (or sets) of reducers are at present installed, together with the necessary switchgear, only one set of cables is run from Stockwell, one set of reducers being able to do the work at full load. Provision has, however, been made for a second set of cables when required for the contemplated extension of the railway to Euston. Either set of reducers can be run as desired. The essential difference between this sub-station and that at London Bridge lies in the method of using the batteries. Here, instead of the ordinary non-reversible boosters, the Highfield system is used, with the result that the batteries are always on the line either discharging or charging.

Each booster (one each for the "up" and "down") consists of a motor, generator, and exciter opposer, all coupled direct to one shaft, the rated capacity of the booster being 420 amperes, with a boost of 150 volts. The machines are capable of taking an overload of 50 per cent. for half-an-hour, and of 100 per cent. overload for momentary peaks. The diagram fig. 5 shows the connections of the Highfield system as employed at Islington, and the arrangement of coupling up the light and lift cables.

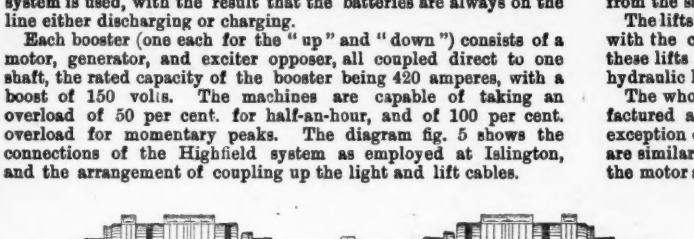


FIG. 7.—REDUCING TRANSFORMER.

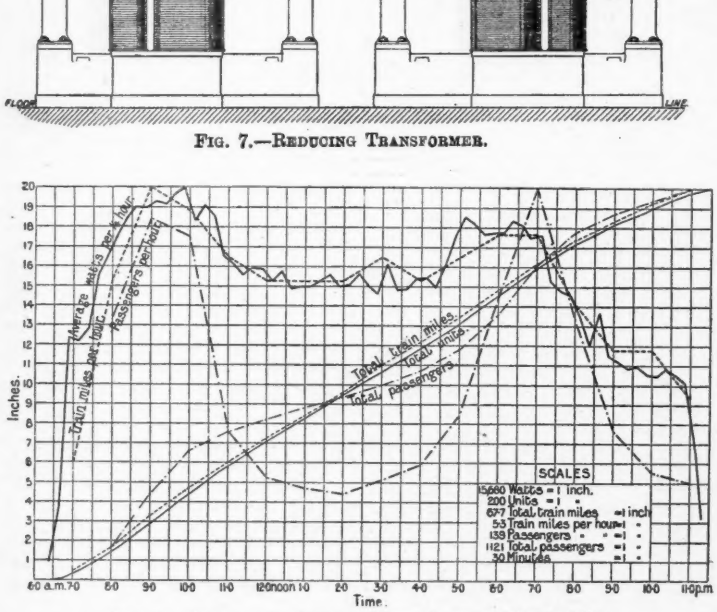

Inches.
Time.
Average watts per hour.
Train miles per hour.
Passengers per hour.
Total train miles.
Total watts.
Total passengers.
SCALES
15660 Watts = 1 inch.
220 Units = 1 "
627 Total train miles = 1 inch
53 Train miles per hour = 1 "
139 Passengers " = 1 "
1121 Total passengers = 1 "
30 Minutes = 1 "
6 a.m. 7 8 9 10 11 12 noon 1 2 3 4 5 6 7 8 9 10 11 p.m.

FIG. 8.—RECORD OF ALL-DAY TEST, JANUARY 18TH, 1894.

The switchboard is similar to that at London Bridge, with the exception of the Highfield panels. The battery consists of 500 Tudor 210 H.B. 15 cells of the following capacity:—

588 ampere-hours when discharging at 84 amperes for 7 hours.					
540	"	"	180	"	3 "
480	"	"	240	"	2 "
420	"	"	420	"	1 "

with a maximum discharge rate of 600 amperes for short periods.

At both sub-stations arrangements are made on the switchboards so that the high-tension cables can be coupled to the bus-bars direct, and feed in as low-tension feeders in case an accident should occur to the high-tension plant.

As already mentioned, there is a battery at Stockwell in connection with the Highfield boosters. The battery consists of 500 Chloride 11 cells of the following capacity:—

245 ampere-hours when discharging at 35 amperes for 7 hours.					
225	"	"	75	"	3 "
200	"	"	100	"	2 "
175	"	"	175	"	1 "

with a maximum discharge of 250 amperes for short periods.

The boosters are similar to those at the Angel sub-station, and have a rated capacity of 175 amperes with a boost of 150 volts.

The battery at the generating station is used only in connection with the supply of current to the lifts on the Clapham extension, and the lighting circuit in parallel with the other sub-station batteries.

Milking transformers are installed at the generating and sub-stations.

The question of carrying the passengers vertically is quite as important as their carriage horizontally, and the costs are considerably more per ton-mile or passenger-mile.

As mentioned earlier in the paper, the lifts on the railway from Stockwell to King William Street are hydraulic, the high-pressure water being supplied from the generating station at Stockwell.

At each of the six stations there are two lifts, the capacity of each being 50 persons. The average travel is about 50 ft.

Kennington station has now only one hydraulic lift, the second one being operated electrically. The method of control consists of a hand rope in the cage, which operates a valve, allowing the water to enter the cylinder as the lift ascends, and to leave as it descends. The hydraulic plant was manufactured and erected by Messrs. Armstrong & Mitchell, of Newcastle-upon Tyne (now Armstrong, Whitworth & Co).

Hydraulic capstans are fitted in the depôt for shunting purposes, and these, together with motor lifts in the repair shops, are operated from the same supply.

The lifts* on the northern and southern extension are electric and, with the converted lift at Kennington, number 26. The cages for these lifts are very similar to those used in connection with the hydraulic lifts, and have approximately the same capacity.

The whole of the 25 electrical lifts on the extensions were manufactured and erected by Messrs. Eastons, of Erith, and, with the exception of the position and size of the motor and winding gear, are similar. In the case of the Clapham and Moorgate extensions, the motor and winding gear is fixed at the bottom of the lift shaft, and in the case of the Islington extension at the top. This latter arrangement is very much more suitable and convenient.

Briefly described, the machinery consists of a compound-wound four-pole motor, on the extended shaft of which is secured a mild-steel, case-hardened worm, geared to a worm wheel having a phosphor bronze rim, with cut teeth, shrunk and keyed to a centre. The worm wheel shaft carries the rope-driving sheave. The eight steel wire ropes passing over this sheave are given additional contact by a similar sheave running light and quite close to the driver; the ropes going over and under these two sheaves form a figure like the letter **S**, which gives an excellent grip, but is more or less objectionable from the point of view of rope renewals.

The cage is suspended from one end of the ropes, and the balance weights from the other. The latter are arranged to balance the weight of the cage and about half the load, this being generally the most economical working arrangement. At stations, however, where the traffic is light, a slightly smaller balance weight proves more economical. Safety arrangements are provided to grip the lift guides somewhat as in the case of the hydraulic lifts. The act of bringing the safety gear into action also cuts off the current from the motor.

The results of working show that the electric lift has many advantages over the hydraulic lift, but in the case, at any rate, of the large lifts, the control of the hydraulic lifts is very much more satisfactory than the electric, both from the point of view of operation and upkeep.

The operation of one simple valve by a hand rope in the cage gives perfect control of the hydraulic lift under all conditions, and with a reasonable amount of care the starting and stopping is perfect, while the speed can be anything desired within reasonable limits. The control for electric lifts is much more complicated and costly. The railway company's liftmen being used to pulling a rope to start or stop a lift, in the earlier days, when converting the hydraulic lift at Kennington to electric working, the simple hand-rope method as used in office lifts was tried, but was found quite unsuitable for the new conditions.

The controlling gear now fitted consists of three sets of switches operated by solenoids. One set closes the motor circuit for the up journey, the other for the down journey, and the third cuts out a starting resistance in the armature circuit. The exciting current for the up and down switches is controlled from a small switch in the lift cage.

An all-day test of the generating plant was made in January, 1894. The coal was weighed and the water measured from starting in the morning at 6 a.m. until the generating station shut down at 11.30 p.m. During the test six Lancashire boilers and two of the Fowler engines were at work. The hydraulic engines operating the lifts were fed with steam from the same boilers, and the amount of coal used for these pumping engines was determined by a previous test which gave six tons per day.

The electrical output of the station was 4,005 units. The following table gives the whole of the results of the day's working. The coal and water per unit generated are very high, due to the fact that the engines were only running with anything like full load for about 5 hours out of the 17·5 hours of the test. In the difference between the units per ton-mile at the switchboard and on the loco-

* A full description of the new electric lifts appeared in our issue of December 13th, 1901, p. 977—979.—EDS.

motive is included the current used in shunting the trains into and out of sidings, and also the transmission losses. The units per ton-mile on board the locomotive were observed when driven under the best conditions, and it is probable that in ordinary working the driver did not take such care in driving. The transmission losses as measured between the switchboard and locomotive were 10·5 per cent. Fig. 8 shows the results plotted.

(To be continued.)

ELECTRIC TRACTION WITH ALTERNATING CURRENTS.

By A. C. EBORALL, Member.

(*Paper read at Manchester, December 15th*, 1903.)

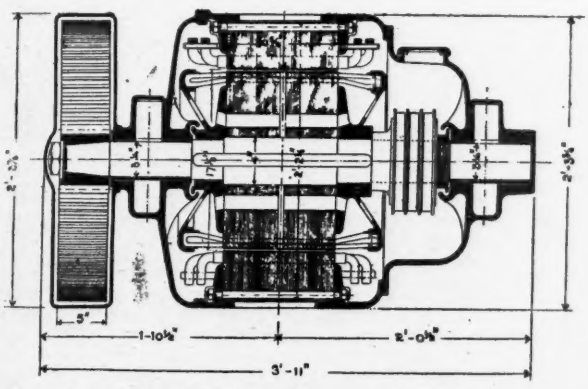
ALTHOUGH the subject of the present paper is somewhat hackneyed, it is hoped that the present brief and general consideration of certain matters in connection with it may be of some interest, and at least give rise to a profitable discussion. It is proposed to deal first with some features incidental to the employment of three-phase currents for railway purposes, and then to refer to the subject of single-phase railway motors. Two years ago the latter were not in existence, but to-day the position is very different. The large amount of attention that has been given to single-phase motors by different engineers since that time has already produced results which seem to indicate that single-phase working may eventually take a certain position as far as electric railway work is concerned.

Before proceeding to discuss specific questions in connection with the subject, it may be as well to say a few words with regard to the sphere of utility of alternating current working as far as electric traction is concerned. The latter has to be considered with regard to various classes of work, the requirements and conditions of which vary very greatly.

Apart from those cases in which the lines can be properly supplied directly from continuous current supply stations, and putting on one side the question of main line electric traction as being at the moment of academic interest only (at any rate, as far as this country is concerned), the following distinct classes of work have to be dealt with as every day problems at the present time:—

(*a*) Urban and inter-urban tramways.
(*b*) Overhead, underground, and suburban electric railways.
(*c*) Branch line and light railways.
(*d*) High speed point to point railways.

As far as those lines of the first-mentioned class are concerned, it is obvious that three-phase working is out of the question; the mere fact of two conductors being necessary and the requirements of uniformity in the equipment of the line and rolling stock are more than sufficient, apart from all other considerations, to bring about this result. Again, even if the single-phase railway motor ultimately becomes an important factor in electric railway work, it would be hardly possible to contemplate a change from present practice. Even if special circumstances allowed of the requirements of uniformity being waived, such questions as the inductive drop in the rails,* relatively inferior all round electrical performance, relatively greater cost and weight of the electrical equipment of the rolling stock, &c., would, it is thought, constitute disadvantages for this class of work which would not be made up for by the advantages of replacing the running machinery in the sub-stations by stationary transformers.



Pinion, 16 teeth, 5¾" diameter, 720 revolutions per minute
Gear wheel, 72 teeth, 26" diameter, 160 revolutions per minute

FIG. 1.—SECTION THROUGH STANDARD GEARED THREE-PHASE RAILWAY MOTOR RATED AT 80 B.H.P., 720 REVOLUTIONS PER MINUTE, 500 VOLTS, AND 25 CYCLES.

With regard to working costs, a certain economy naturally results owing to the substitution of transformers for rotating converting machinery in the sub-stations, but it is thought that this saving will not appreciably influence the total costs of operation, on account of the increased energy consumption in the secondary network. It is hardly likely that the all-round performance of any type of alternating current equipment will ever equal that of the corresponding direct current equipment—at any rate under the conditions usually prevalent in urban and inter-urban tramway work. However perfect the phase compensation of such motors may become, the losses in them and in the distributing system must be greater, other conditions being equal, while, on the other hand, the maintenance charges are not likely to be less.

With regard to (*b*), which implies, as a rule, the handling of a large number of trains running at short intervals for the greater part of the day, there is more to be said in favour of alternating current working throughout; but here again, in the present state of our knowledge, there can be little doubt which method is the better. The commercial success of such lines, which alone is the criterion by which the quality of the engineering portion of the work can be judged in the long run, turns very largely upon the question of rapid acceleration attained at minimum cost with the help of simple and flexible arrangements, and in this respect the direct current equipment is superior to the alternating current equipment, no matter what arrangements are made with regard to the starting and speed control of the motors. The better performance of the direct current motors in this respect outweighs the disadvantages inherent to extended systems supplied with energy from a considerable number of rotary converter sub-stations, and consequently recent decisions to employ direct current working on certain important suburban lines, now in course of electrification, are not to be wondered at.

TABLE I.

Leading particulars.	Type of motor. Three-phase.	Direct current.
Normal rating at 500 volts ...	80 B.H.P.	80 B.H.P.
*Momentary safe overload ...	200 „	160 „
Speed at 1¼ full load	717 r.p.m.	650 r.p.m.
„ 1/1 „	725 „	710 „
„ ¾ „	732 „	790 „
„ ½ „	739 „	940 „
„ ¼ „	745 „	1,250 „
Efficiency at 1¼ full load... ...	89%	86%
„ 1/1 „	90%	88·5%
„ ¾ „	90·2%	87%
„ ½ „	90%	83%
„ ¼ „	86·5%	74%
Power factor at 1¼ full load ...	85·5%	—
„ „ 1/1 „ ...	83·5%	—
„ „ ¾ „ ...	78·5%	—
„ „ ½ „ ...	66%	—
„ „ ¼ „ ...	45·5%	—
Current at 1¼ full load	113	174
„ 1/1 „	92	134
„ ¾ „	73	103
„ ½ „	58	72
„ ¼ „	44	41
† „ no load ...	38	—
Net weight, including gear ...	1·7 tons.	1·53 tons.
Overall length	47 in.	38·5 in.
„ breadth	48 „	44 „
„ height	40 „	28 „
Length of air-gap	0·069 „	0·25 „
Relative cost of motor	1·25 „	1
‡Relative cost of two controllers and the resistance	1·2	1

* For 3 minutes.
† Power factor = 8·4 %.
‡ Series-parallel control for the direct current equipment, and control with rotor resistances only, for the three-phase equipment.

But with regard to the classes of work enumerated under (*c*) and (*d*) above, where the distances are usually considerable and the acceleration periods are relatively insignificant, the case is quite different. For such work the disadvantages of three-phase working, for instance, are by no means serious, while the advantages gained with regard to lower first cost and much smaller operating charges are such that it is difficult to imagine lines such as those projected between Manchester and Liverpool, London and Brighton, &c., being laid out for direct current working. There can be little doubt but that electric traction on lines of this character, as well as on light railway lines generally, will be carried ont with alternating currents in the future, and it is in connection with this class of work that the following observations are more particularly applicable.

THREE-PHASE WORKING.

Motors.—In Table I., above, a comparison is given between typical standard high-speed 500-volt railway motors of the three-phase and direct-current types, the former arranged for 25 cycles. The rating of each motor is 80 B.H.P. at 720 revolutions, the temperature rise of each motor not exceeding 75° C. after a run of one hour at this load in either case. A section of the three-phase motor is given in fig. 1, and the circle diagram for it in fig. 2.

The table referred to shows at a glance the relative performances of the two classes of motor, although the direct current motor would certainly appear to somewhat greater advantage at a lower and more usual speed; the contrary would be the case, however, for the three-phase motor. The latter, it will be noticed, has an excellent efficiency curve, this having been specially aimed at in the design, and from this point of view the three-phase motor is quite as good,

* For information bearing on this matter, see Mordey & Jenkin, *Proc.* Inst. Civil Engineers, 1902, p. 58; Huber, *Street Railway Journal*, June, 1902, p. 470; Herzog and Feldmann, *E.T.Z.*, 1900, Nos. 41 and 42.

at all loads, as the best direct current motors of corresponding output.

It will be noticed, however, that the power factor at different loads has a lower value than the corresponding value for three-phase motors used for ordinary work, but this is wholly due to the relatively large air-gap. The motor in question has a rotor having an external diameter of 17¼ in., and for stationary work an air-gap length of 0·04 in. would be a usual and permissible value for this size of rotor. It is, however, too small for railway work, and increasing it by nearly 75 per cent. has, naturally, a large influence on the power factor. From the figures given above it will be seen that at full load 83½ per cent., and at half-load 66 per cent., of the current actually taken by the motor is an energy current.

It will be seen from the table that there is no great difference between the weights and dimensions of the two types of motor, what difference there is being in favour of the direct current motor. But the cost of the three-phase equipment is considerably

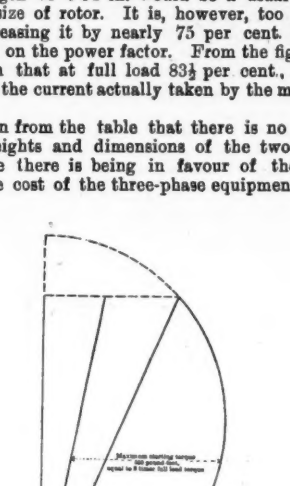


FIG. 2.—CIRCLE DIAGRAM FOR THE 80 B.H.P. THREE-PHASE RAILWAY MOTOR SHOWN IN FIG. 1.

in excess of that of the direct current equipment, this being due, to a certain extent, to the expensive character of the controlling gear for the three-phase motors. As a matter of fact, the difference is even greater, when the cost of the entire car equipment is compared, principally on account of the expensive character of the wiring (especially in the rotor circuits), but also on account of the additional apparatus, current collectors, switches, protective devices, &c., required in the three-phase case.

As to which is the better motor, considered from the engineering and cost of upkeep points of view, the three-phase motor has the advantage. With air-gaps of the order referred to above, no trouble is experienced in practice, provided that the bearings are properly proportioned in the first place and well looked after in the second. As far as the entire equipment is concerned, it must be remembered, moreover, that as a partial set-off to the very considerable disadvantages possessed by such a three-phase equipment with regard to economical speed regulation, and the collection of the currents from two or more trolley wires, it is possible to work with high pressures on the motors, and hence realise a considerable saving for the case of lines of considerable length. The limit in this direction really turns upon the question of the maintenance of effective insulation of the stators of the motors, for no matter what system of control is employed, no handling of high pressure gear is necessary. For such cases as those included under (*c*) and (*d*), the stators of the motors can invariably be left on,* and the entire control (except reversing) effected on the rotors; with infrequent stops and long runs this is entirely practicable, and for the rest, there is no difficulty with regard to the cutting off or reversal of the stator current at the termini, with the help of the excellent types of oil switches (requiring but little space) which are nowadays available.

But, although pressures of 3,000 and 6,000 volts are used for railways actually at work (and 10,000-volt railway motors have even been made), it is thought that the use of really high pressures for such work is open to serious criticism. It is by no means difficult to construct railway motors of large size to work at such pressures, but the effective maintenance of the insulation under the conditions prevalent in railway work is another matter. What with the effect of vibration on the durability of the insulation (which, it must be remembered, is always at a high temperature on account of the considerable and constant losses in the iron of the stator) and the difficulty of keeping out dirt, moisture, and oil, it is thought that the employment of pressures greater than about 2,000 volts is in general a mistake. At this pressure, and even at lower pressures, the energy necessary for the heaviest trains can be collected without difficulty by modified forms of the current collectors at present in use, and although the cost of the line and distributor is more, yet it is surely better to spend money once and for all on this part of the work than to spend it in repairs on the motors. Again, the indirect consequences of breakdowns in railway work are far more serious than in any other, absolute reliability being the first consideration. Owing to its nature electric traction cannot be so reliable as steam traction when it comes to really heavy work, and, knowing this, electricians should surely go out of their way to reduce risks of breakdown to an absolute minimum, even if it does cost more in the first place.

Speed Control.—It is a trite saying that the speed control of the three-phase motor is its weak feature; unfortunately, as far as railway work is concerned, this is indeed the case. There is, of course, no difficulty in regulating the speed of three-phase railway motors, or in properly controlling or handling the trains and fulfilling service requirements, but the control of the motors is accompanied either by great waste or by considerable complication. These difficulties increase when rapid acceleration is an essential requirement, and it is for this reason that three-phase working for the class of work included under (*b*) is outside serious consideration.

Of the various methods that have been proposed for controlling the speed of three-phase motors, two alone are applicable to railway work, namely, rheostatic (rotor) control and tandem parallel control. The former method is in use on all the three-phase lines at present in operation (including the Zossen experimental line) with the exception of the Valtellina Railway, where tandem parallel control has been adopted by Messrs. Ganz & Co. This latter method of working was also proposed by the same firm in connection with the electrification of the Metropolitan District Railway in London, and the essential features of each method will now be briefly dealt with.

Unlike the direct current series motor, the speed of which adjusts itself automatically, in accordance with the torque which the motor is called upon to exert, the three-phase motor (or any induction motor) possesses the undesirable property, as far as railway work is concerned, of carrying all loads within its capacity at nearly the same speed; thus the 80-B.H.P. motor already referred to has a slip of only 1¾ per cent. at a load of 200 B.H.P. The absence of inherent speed regulation for varying torque means that, if left to themselves, the three-phase motors on the cars will draw them up the steepest gradients on the lines at nearly the same rate as on the level, and as this relatively large amount of power has to be provided for, the practical effect of this is that the capacity of the power station and sub-stations has to be in general about 30 per cent. greater than that of the corresponding direct-current lay-out for a given running schedule on a given line.

A reduction of the speed of the motors on the inclines by means of rheostatic control evidently does not help matters in this respect. The power that would otherwise be taken up by the train is now wasted in the rotor resistances, the net result being that, while a slower speed has been attained, the efficiency of the operation has decreased proportionately. The introduction of resistances into the rotor circuits is then analogous to the regulation of the speed of a shunt motor (working with constant field excitation) by means of resistances in the armature circuit. In both cases the energy input into the motor remains nearly constant, as for a given torque the current is nearly independent of the speed. In both cases the method of speed control in question is wasteful in the highest degree, and requires large and expensive resistances, which must be properly ventilated, and for which it may be a difficult matter to find the necessary room on the car. It follows, therefore, that rheostatic control of the speed of three-phase motors on the gradients of the line is useless from the point of view of power economy, and this is why it is never attempted in practice. In addition to the disadvantage relative to the capacity of the power plant already noted, it will be seen that the absence of inherent speed regulation on the part of the three-phase motor has the further disadvantage that the amount of the load on the motors cannot in general exceed a certain definite amount. Thus, for instance, on a line having severe gradients, it would in general be advisable to take advantage of the excellent overload capacity of the three-phase equipment to work the motors at an output well above full load on the steepest gradient, and this would mean (after making proper allowances for the varying state of the track and for possible variations in the motor pressure) that an emergency traffic could only be handled properly with the help of additional trains; the addition of a few more coaches to the standard trains might stall the motors on the worst gradient of the line. It is for this reason that the motors on the goods locomotives on the Burgdorf-Thun line are provided with two speed gears, which is one way out of the difficulty. Another way is to work normally with such a margin of power on the motors that, notwithstanding possible variations in the condition of the track and in the supply pressure, considerable emergency loads can be handled on the worst gradients should the necessity arise. This means that the best property of the three-phase equipment—its great overload capacity—is not fully utilised in normal work, and that difficulties will probably arise in connection with getting the motors into the available space.

In all these matters the great influence of variations in the supply pressure on the performance of the motors must not be overlooked. Whereas the torque of the direct current equipment is unaffected by variations in the line pressure, the torque of the three-phase motors varies with the square of the pressure at their terminals. Thus, for instance, referring to the 80 B.H.P. three-phase railway motors shown in fig. 1, the maximum load it can safely exert for a few minutes is 200 B.H.P. at 500 volts; at a pressure 7½ per cent. below this it falls to:—

* This, the author believes, is what is done at Valtellina. Of course, for the class of work included under (*b*) this method of working would no longer be possible, on account of the continual waste of energy in the stators of the motors—for instance, the iron loss in the stator of the 80-B.H.P. motor, shown in fig. 2, and referred to in Table I., amounts to 2 KW. The continual switching on and off of the stators of high-pressure motors could not be seriously contemplated, and hence the employment of such motors for this class of work is practically out of the question.

$$\text{Maximum B.H.P} = 200 \times \frac{(462)^2}{(500)^2} = 172.$$

It follows that the transformers supplying current should be so located along the track that on the gradients the full pressure is maintained on the lines under the service conditions; on the worst gradients it is desirable that this pressure should be even higher, which can be readily arranged for by arranging the transformers at such points with smaller transformation ratios. Another point is that an ampere-meter and a voltmeter should form part of the equipment of the motorman's cab, and that their indications should be properly taken into account by the motorman at starting. Otherwise it might quite well happen, for instance, that careless handling of a train at starting on a gradient might stall the motors. The pressure at starting would fail, and with it the torque. Giving the motor more current might not improve matters, as this might bring about such a further reduction in the pressure that the torque would decrease still more, and so on. Naturally, starting on gradients is to be avoided as much as possible, but the occasional pulling up of a train on a bad gradient has to be reckoned with.

(To be continued.)

ON THE DISTRIBUTION OF LIGHT FROM INCANDESCENT LAMPS.

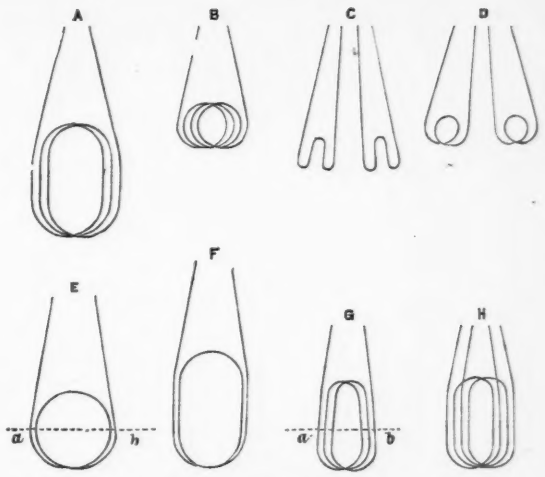
By LANCELOT W. WILD, A.M.I.E.E.

THE candle-power given by an incandescent lamp varies in different directions. The distribution of the light obtained from different lamps also varies. The two chief factors influencing the distribution of the light are the form of the filament and its position in the bulb.

Let us consider the case of a perfectly straight filament suspended vertically, and let us for the present neglect the effects produced by the reflective surfaces of the bulb. The light distribution in a horizontal plane should be perfectly uniform, and at angles below or above the horizontal the candle-power should be proportional to the apparent surface of filament as seen from these positions. In other words, the candle-power varies as the cosine of the angle of elevation or depression from the horizontal. The light emitted in a direction at 90° to the horizontal will be zero.

as a measure of the mean spherical candle-power of the lamp.

In practice it is found that the light emitted in any direction is not strictly proportional to the apparent surface of filament presented to that direction. The cause of this discrepancy is as follows:—The glass bulb of the lamp does not transmit all the light rays that fall upon its surface, but reflects back a portion. The surface being curved and the filament not being equidistant from all parts of the bulb, the light reflected is, to a certain extent, concentrated into particular directions. So marked sometimes is the effect of this concentration that it is found that rotating the lamp



SHAPES OF FILAMENTS TESTED.

through only quite a small angle increases, the light falling upon the photometer by as much as 50 per cent. This effect is seldom found, however, to this marked degree with filaments of the form now generally manufactured.

When the direction in which the best illumination is

DISTRIBUTION OF LIGHT GIVEN BY VARIOUSLY-SHAPED FILAMENTS

Filament	A.	B.	C.	D.	E.	F.	G.	H.	Mean.
Candle-power, 90 above horizontal	0	0	0	0	0	0	0	0	0
Mean candle-power, 60 above horizontal	5·3	6·4	4·15	4·75	6·8	5·4	5·7	4·75	5·41
Mean candle-power, 30 above horizontal	8·7	8·6	8·9	8·75	8·7	8·7	8·6	9·1	8·76
Mean horizontal candle-power	9·9	9·3	9·9	9·65	9·25	9·7	9·6	9·8	9·57
Mean candle-power, 30 below horizontal	8·9	8·3	9·4	9·35	8·85	9·2	9·8	9·1	9·15
Mean candle-power, 60 below horizontal	6·2	7·0	7·7	7·7	7·4	6·4	6·4	6·5	6·91
Candle-power, 90 below horizontal	4·2	5·8	4·15	5·8	6·8	4·6	3·3	4·0	4·83
Candle-power in a direction normal to mean plane of filament	10·0	10·0	10·0	10·0	10·0	10·0	10·0	10·0	10·00
Mean spherical candle power	8·3	8·35	8·45	8·45	8·45	8·3	8·4	8·35	8·38
Mean spherical candle-power / Normal candle-power	·83	·835	·845	·845	·845	·83	·84	·835	·838
Mean spherical candle-power / Horizontal candle-power	·34	90	·855	·875	·915	·855	·875	·85	·871
Candle-power, 90 below horizontal / Normal candle-power	·42	·58	·415	·58	·68	·46	·33	·40	·483

Now let us consider the case of the two filaments E and G, as shown in the annexed diagram. Allowing for the difference in the length of the two filaments, it will be seen that E presents a larger apparent surface than G when viewed at an angle of 90° below the horizontal, whereas, in the direction *a b*, G presents the greater surface. When viewed horizontally, but at right angles to *a b*, both filaments disclose their whole length to the observer. We should, therefore, expect to find that if both filaments give the same candle-power horizontally, and at right angles to *a b*, then E will give the larger candle-power vertically downwards, whereas G will give the greater candle-power in the direction *a b*. It follows from this that the mean horizontal candle-power will be greater in the case of G than E. The mean spherical candle-power of both filaments should be the same, and this is borne out by the accompanying table. This table also shows that the candle-power measured normal to the mean plane of the filament (hereinafter called the normal candle-power) can generally be accepted

required is not specified, lamps should be tested for mean spherical candle-power. As, however, this measurement is somewhat tedious, many substitute for it the measurement of the mean horizontal candle-power of the lamps to be tested. The mean horizontal candle-power is very far from being proportional to the mean spherical candle-power, as will be seen from an inspection of the table.

A far better plan than measuring the mean horizontal candle-power is to measure the normal candle-power. The advantages of only making this measurement are as follows:—

Only two measurements need be made—namely, one from each side of the lamp. The mean of the two is taken if there is any variation.

A small error of angle in setting the lamp in position only gives rise to a small error in the measurement. Reflections are generally at a minimum in this position.

The writer has tested eight lamps for candle-power at all angles, and has embodied the results of the tests in the

accompanying table. Diagrams of the filaments are also given drawn to scale. The lamps were chosen for the diversity of shape of their filaments. All lamps were marked as 200 volts and 16 C.P. with the exception of E, which was marked 100 volts, 16 C.P. To facilitate comparison all the measurements have been brought down to one common basis—namely, 10 C.P., normal to mean plane of filament.

It will be noticed that whereas the mean horizontal candle-power varies from 9·9 to 9·25, yet the mean spherical candle-power only varies from 8·45 to 8·3. The ratio of mean spherical candle-power to mean horizontal candle-power varies from ·915 to ·84, whereas the ratio of mean spherical candle-power to normal candle-power varies only from ·845 to ·83.

Of course, it is not pretended that lamps with abnormally shaped filaments, or with a portion of the bulb made of opal glass to act as a reflector, would conform to these conditions.

Speaking generally, it can be seen that when the mean horizontal candle-power is high the vertical candle-power is low, and *vice versâ*, but no distinct law can be traced.

For the general illumination of a room a lamp should be chosen giving high candle-powers horizontally, and at 30° below the horizontal. Filament G appears to best fulfil the conditions.

When a lamp is required to illuminate a small area such as an office table, a filament should be chosen giving as much light as possible vertically downwards, and also at 60° below the horizontal. These conditions are best fulfilled with a filament of the form of E.

NEW TWO-RATE METER.

By E. S. SHOULTS.

THERE is no doubt that one of the most serious hindrances to the spread of electric lighting, and the increased use of electric power in factories and workshops, is the difficulty which is experienced by electrical supply companies and corporations in obtaining a reasonably steady demand throughout the 24 hours of the day.

Various methods have been adopted for inducing customers to take their load as regularly as possible through the medium of special systems of charging, by which rebates are given in consideration of a consumer's willingness to adapt his requirements to the convenience of the supplier. These systems have been developed with great ability, and in some cases pushed with great energy, and there is no doubt whatever that they do to some extent produce the desired result.

A plain system of rebates founded on the quantity used, though having the advantage of extreme simplicity, is open to the objection that all customers are not treated alike, and small consumers might very reasonably complain of injustice on that account. Further, it ignores the fact that small consumers are generally good customers, in that they tend to keep the demand curve level, and it in no way helps to improve the load factor.

There are many other arrangements of varying simplicity and effectiveness; to obtain the best results it is necessary to discover that one, which, while having a reasonably good effect in improving the load curve of the station, does not add to the expenses incurred in distribution, the complication of the apparatus employed, or the difficulty of satisfying consumers that they are being fairly dealt with.

The nature of the demand in a locality will also have to be considered. In some districts there is a plentiful supply of customers for power during the day, whereas in others the lighting load is the only one available. Then again, in some places this power load will overlap the demand for lighting, while in others the factory hours may be such that the two demands will not interfere with one another at all. In medium-sized manufacturing towns it is hardly too much to hope that it may be possible, in the course of time, to persuade employers of labour to avail themselves of the greatest possible amount of daylight by offering them the inducement of a cheap power supply, on the condition that they so arrange their hours as to interfere as little as possible with the demand for light.

A careful consideration of the method adopted by Dr. Aron in this two-rate meter will show that all these varying conditions are well met; particular attention has been paid to the difficulties in dealing with consumers, and the whole system, and the apparatus for carrying it into effect, is so simple that it can easily be understood and appreciated by any and every class of consumer.

This, after all, is one of the most important essentials. It is of very little service to a supplier to give rebates or sell electrical energy cheaply if the consumer is all the time under a vague and ill-defined impression that he is being cheated. That this is the case with some of the systems in use is well known, and there are instances to be found where a man has cheerfully paid more for his energy on a flat rate which he understood than on a complicated system of charge based on calculations which were beyond his mathematical powers.

The instrument is illustrated in figs. 1 and 2. To the left of the meter will be seen an ordinary clock, which is electrically wound, having two extra dials, one of which makes a revolution once in 24 hours, the other showing seconds. The first is necessary, owing to the fact that the clock having only a

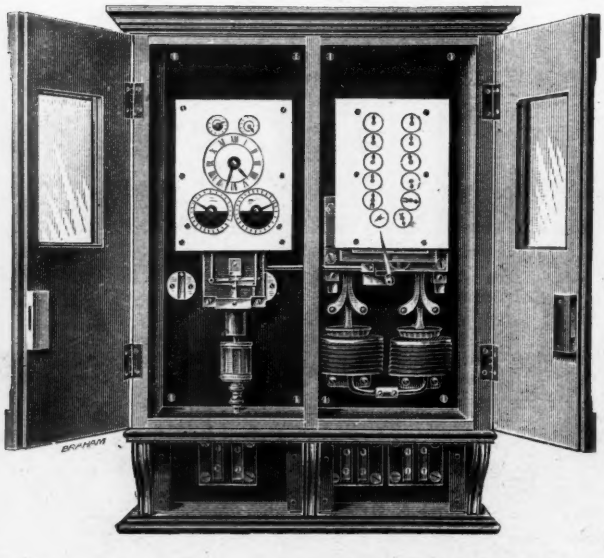


FIG. 1.—ARON TWO-RATE METER.

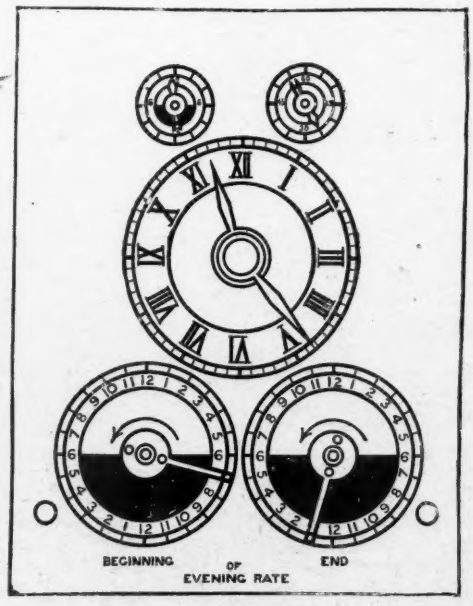


FIG. 2.

12-hour dial, no distinction is made between day and night. The second is provided so that the regulation of a large number of the clocks may be carried out in as short a time as possible. Underneath that belonging to the clock itself, are two more dials with 24 divisions giving the 12 hours for day and night respectively, these dials being supplied with pointers which can be revolved in a counter-clockwise direction and so set at any hour by hand, the pointer on the left dial generally representing the beginning, and that on the right the end of the high rate period (see fig. 2).

By this means the 24 hours can be divided into two portions, the shorter one generally corresponding to the peak, when the charge per unit will be at its maximum, and the longer one to the period during which the charge is greatly reduced; for instance, in ordinary working, the left-hand dial could be set at, say, 5 o'clock in the evening, and the right-hand dial at 9 or 10. The distinction between day and night is made by the black-and-white paintings on the dial centre.

On the right-hand side is the meter, which is in all essential particulars an ordinary Aron meter; the dials, however, are placed in a vertical row, and an extra set is provided so that by means of a change-over gear fitted at the bottom of the dials, the record will be made alternately on the left, and on the right set of dials according to the setting of the two pointers underneath the clock dial, as above described. An indicator on the meter side (seen in fig. 1) shows which set of dials is in use, and the whole arrangement is visible through the windows, and in this way is quite open to the consumer.

An engineer having only a lighting load, will naturally set the pointers to correspond with the period of his peak load, and as the apparatus is perfectly straightforward, and can be easily understood by any consumer of ordinary intelligence, it is pretty certain that the effect of the extended use of these meters will be to level out the peak and raise the lower parts of the load curve; for private consumers, realising that before and after a certain hour in the evening they can get their energy at a much cheaper rate, will practise economy during the critical period, and will, in all likelihood, more than make up afterwards by using their light freely during the cheaper time.

A further advantage of this system is that the time of high rate can be varied with the time of year, it being only necessary to give the consumers due notice that the change will be made.

It is, however, in districts where there is a daytime demand which can be developed that the Aron Double Tariff Meter is especially useful. A factory can by means of one of these meters be supplied with power during the hours of light load at the station, at prices comparing most favourably with the cost of the same as produced through steam or gas engines. As a general rule, this factory demand will not clash with the centre of the lighting peak, and even though it should do so to a slight extent, the power peak would never coincide with the lighting peak. Further, the system does not impose any restrictions on the user as to when he may use his power, as manufacturers, finding it occasionally necessary to work overtime, would not be seriously disturbed by the fact that the power required for those few hours was more costly.

A word must be said as to the extra cost involved in the introduction of systems of this kind. The arguments adduced in support of all economising contrivances are similar, but it is certain that their adoption can only be justified when the amount recovered by them is more than that spent in obtaining it; this much is obvious, but, owing to the difficulty in estimating the efficiency of such contrivances, the advantages gained must not merely exceed, but be considerably and evidently in excess of the cost involved.

The real alternative to Dr. Aron's double-tariff system is the introduction of two separate circuits into factories, and places where electricity is to be used for heating, or power, as well as for light, and it is clear that in such cases the cost of using the two-rate meter is considerably less than that involved in the extra wiring of double circuits, with separate meters.

The advantages to be obtained from the adoption of Double-Tariff meters on purely lighting circuits, where many of the consumers will be quite small, are less obvious, but none the less real.

There is no doubt whatever that the effect of the use of these meters throughout a system would be to level the load curve, and consequently the amount of plant required to deal with the load would be reduced. There is little doubt that the extra expense involved in providing two-rate meters, will be more than met by the reduction of capital expense in extra plant required to deal with the peak, and when it is remembered that many stations charge a rent for meters in some way proportioned to their original cost, whereas they cannot charge rent for the extra plant provided to supply the peak, it will be seen that the advantages are, on the whole, well on the side of the adoption of this system.

It is found in practice that consumers when given a choice between a flat rate with a low meter rental, and a double rate with the higher meter rental necessarily involved, readily select the latter, and, moreover, as the meter is provided with a really excellent clock, which must go well, and is looked after by the station people, it is found that consumers appreciate this advantage and insist on having the meter placed in a good situation so that the clock can be of use to them. This, of course, is an incidental advantage, but there is no doubt that where it is possible to please consumers it is advisable to do so.

The advantages of this double tariff meter can be summed up as follows:—

1. It can easily be explained to any consumer.
2. The consumer can see for himself that the apparatus is working properly, as the indicators are all open to his inspection.
3. The amounts used on each rate are recorded, and can therefore be invoiced, separately, so that both the supplier and the consumer can arrange matters to get the best result.
4. The consumer's interest can be made to agree with that of the supplier, and the arrangement can be modified to suit special conditions, such as time of year and nature of load.
5. No restrictions whatever are placed on the consumer as to when or at what rate he may use his supply, but the desire to economise will tend automatically to keep down the peak of the load curve.
6. Day loads will be encouraged, so that the improvement in the load factor will be made not only by reducing the peak, but also by raising the lower parts of the curve.
7. The apparatus is supplied with a good clock, which will be appreciated for its own sake by many consumers.

SOME NOTES ON TOWER WAGONS.

By L. E. HARVEY, A.M.I.E.E.

Tower wagons for work in connection with tramways may be roughly divided into three classes, viz.: (1) pole-planting derricks; (2) line construction wagons; (3) emergency repair wagons. All of these differ in construction according to the work they have to do, and a few notes on them may be of interest.

1. *Pole-Planting Derricks.*—These wagons should be very substantially built to withstand heavy roads and heavy weights, and should be strong enough not only to raise and plant the largest sizes of poles with their bases on, but also to pull up old poles without having to excavate round them more than, say, 4 ft. deep. The following is a description of a very good form of wagon:—The derrick or jib is made of two good sound oak beams about 6 in. × 3 in., set on edge, their bottom ends at the front of the wagon, and separated by nearly the width of the wagon, and their top ends nearly close and separated by the width of a 2-in. pulley wheel. These two beams have about three struts, at distances down their length connected to them by iron straps bolted to the struts. About 2 ft. from the top ends two similar vertical oak beams are scarfed, and the bottom ends of these are tenoned into two horizontal deals about the same size, and running the whole length of the wagon, and into the other ends of which the bottom ends of the jib beams are scarfed. Near the tops of the jib beams straps are fixed and bolted to the top of the platform of the wagon. The top ends of the jib beams have plates screwed on, through which the spindle of the pulley is put, and from the outside ends of this spindle a large D shackle is hung downwards, this being of great use to hook a set of blocks on. A winding drum is attached to the bottom ends of the jib beams, and should preferably have two gears, say, a 12 to 1 and a 3 to 1; it is fitted with a removable handle at each end of the spindle, which latter is sufficiently long to allow of two men at each handle, and to be quite clear of the wagon sides. Four men are generally enough to raise poles with the higher gear, the lower being useful in pulling out poles and at times when the gang is short-handed. The drum itself is of cast-iron, about 6 in. to 8 in. diameter, fitted on to a square spindle. The rope is of

"plough" steel, about ⅝ in. diameter, and is fitted with a strong open steel-swivelling hook. The uprights of the wagon are boarded round to form a cabin about 8 ft. high; the latter is large enough to store all digging and concreting tools, and has a bench and vice fitted. The top platform need not be very large, but should be fitted with a strong hand-rail. A side ladder is preferable, as it is out of the way of the jib.

2. *Line Construction Wagons.*—These should also be strongly built, and the tower itself should be particularly substantial to allow for at least four men working on top. Perhaps the best design is one with a fixed main platform (not swivelling) and a hinged extension on the side. The main platform should be about 5 ft. square, and have a strong hand-rail, about 2 ft. high, fixed to its floor by angle-irons. The hinged extension should also be about the same size, and supported underneath by two hinged iron rods fitting into sockets in the side of the uprights of the wagon. This platform is particularly useful in erecting bracket arms and scroll work, and also, where a steam or horse road is being converted, it reduces the necessity of shifting the wagon every time a car passes, as the wagon itself can stand just clear of, and the platform extend over, the track. This wagon should also have a large cabin fitted with vice and all useful tools, and with lockers to store all necessary line material, ready-made bowstrings, blocks and tackle, temporary anchor stays, &c. The ladder for this wagon is best placed at the back end, and here also is fixed, from one of the uprights, an iron bracket sufficiently strong to support a fire basket for soldering irons, and long enough to let it hang well clear of the wagon.

3. *Emergency Repair Wagons.*—These should be as light as possible consistent with strength, as they only have to negotiate properly made-up roads. They should have some sort of extension tower, and the writer is of opinion that the lightest and most handy method of raising this is by means of a steel rope and drum. With this arrangement the pawl engaging the ratchet of the drum should have a spring to keep it to its work; on one occasion the writer was left hanging to the trolley wires owing to the pawl not having a proper grip on its ratchet. A revolving platform is convenient, and this should be fitted with a strong fixed handrail, the folding-down rails being very shaky and liable to give when most required to be firm. A tool box should be fitted to the top platform to take all most useful tools, and a few ears, insulating plugs, bolts, &c., so as to be always ready for a breakdown, and to save the time of hauling them up on top at the last moment.

Here a few words must be said about the wheel-gauge of these emergency wagons. Many nasty accidents have occurred owing to a too narrow gauge. The back wheels should be at least 6 ft. apart, the front ones may be 6 in. less than this. If a less gauge than this is used, considerable risk is run when the tower is extended and the wagon is set on the fall of the road with its side wheels in the channel, to say nothing of turning the wagon round on a hill with men on the top platform. Trenton wagons, as imported into this country from America, are bad examples of narrow gauge, being about 4 ft. 8 in., and this is totally inadequate to their height when extended, especially as the under-wagon is fairly light and consequently the centre of gravity high up.

The heavy construction wagons should have the horse in shaft and a chain horse when necessary, and be fitted with band-brakes worked by a hand-wheel. The emergency wagon should have a pair of horses with centre pole, and these horses are best of the heavy carriage or fire engine type, fairly fast and strong, and very steady when standing. The wagon wheels should be invariably skotched both back and front when men are on top.

Automobile emergency wagons are now coming to the fore, and there is no doubt that they are very suitable for this class of work, as they are very speedy, their under-carriage is heavy and low down, and they can be shifted back or forward very steadily, to say nothing of their running costs being much less than those of two horses, and of their taking less stable room and being quicker started out. Leeds, Bradford and Aberdeen have now got these wagons. Bradford was the first in the field, and they found it so handy and economical that they recently purchased a second. This is a four-cylinder Milnes-Daimler truck, the superstructure being designed and made at the tramway depôt. Leeds got a precisely similar truck and fitted a superstructure on the same lines as the Bradford one, and the writer has been assured that they are far better than horse-drawn wagons in every way.

NEW PATENTS APPLIED FOR, 1903.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

27,316. "Improved arrangements for automatic supply of electricity." F. J. WARDEN-STEVENS. December 14th.

27,330. "Multi-party line systems." W. FAIRWEATHER. (The Stromberg Carlson Telephone Manufacturing Co., United States.) December 14th. (Complete.)

27,350. "Improvements in electric, gas or vapour lamps." F. W. LE TALL. (H. N. Potter.) December 14th.

27,410. "Improvements in and relating to automatic electric circuit-breakers and measuring instruments." H. W. CLOTHIER. December 15th.

27,373. "Improvements in electric arc lamps." J. L. DAVIES. December 14th.

27,446. "An improved form of mechanical car for suspending overhead lines or wires, especially for electric traction purposes." F. REA and E. J. REINDORP. December 15th.

27,456. "Improvements in electric ignition particularly applicable for ernal combustion engines and the like." F. H. DE VEULLE. December h.

27,497. "Improvements in devices for lighting gas burners by electricity." A. MCDOUGALL DUCKHAM. December 15th.

27,505. "A new or improved method of testing for grounds and short circuits in electrically-operated cars or trains." C. A. CARUS-WILSON. December 15th.

27,506. "Improvements in dynamo-electric machinery." A. P. WRIGHT and A. H. MIDGLEY. December 15th.

27,576. "Improvements in magneto-electric igniting apparatus for internal combustion engines." W. ROOS. December 16th. (Complete.)

27,585. "An improved casing and holder for electric wires." H. J. WALKER. December 16th. (Complete.)

27,654. "An improved starter and automatic cut-out for electric motors." VERITYS, LTD., and G. O. DONOVAN. December 17th.

27,662. "An improved device for attaching the circuit wires to the terminals of electrical apparatus." A. F. GUY, F. H. WHEELER and J. A. DAVENPORT. December 17th.

27,677. "Improvements in or applicable to dynamo-electric machinery." F. J. HOWITT and P. R. JACKSON & Co., LTD. December 17th.

27,712. "Improvements in electric glow lamps with metallic filaments." C. D. ABEL. (Siemens & Halske Aktiengesellschaft, Germany.) December 17th.

27,733. "Improvements in and relating to electrically-driven suspended railways." T. A. HEARSON. (A. Bleichert & Co., Germany.) December 17th. (Complete.)

27,734. "Safety device for the switches of electrically-driven suspended railways." T. A. HEARSON. (A. Bleichert & Co., Germany.) December 17th.

27,736. "Improved electrical means for starting prime movers." J. Y. JOHNSON. (The Elektrizitats Aktien Gesellschaft vormals W. Lahmeyer & Co., Germany.) December 17th. (Complete.)

27,765. "Improvements in trolley heads for electric tramways and light railways." F. O. J. ROOSE. December 18th.

27,783. "Improvements in or relating to storage batteries or electrical accumulators." THE ROMANOFF (LONDON) SYNDICATE, LTD. (H. de Romanoff, France.) December 18th.

27,891. "Improvements in bearings for electric or other measuring instruments." THE BRITISH THOMSON-HOUSTON CO., LTD. (The General Electric Co., United States.) December 19th.

27,892. "Improvements in brush-holders for dynamo-electric machines." THE BRITISH THOMSON-HOUSTON CO., LTD. (The General Electric Co., United States.) December 19th.

27,893. "Improvements in controllers for electric motors." THE BRITISH THOMSON-HOUSTON CO., LTD. (The General Electric Co., United States.) December 19th.

27,894. "Improvements in alternating-current dynamo-electric machines." THE BRITISH THOMSON-HOUSTON CO., LTD. (The General Electric Co., United States.) December 19th.

27,895. "Improvements in electric synchronising devices." THE BRITISH THOMSON-HOUSTON CO., LTD. (The General Electric Co., United States.) December 19th.

27,921. "Improvements in systems for the automatic control of electric motors." OTIS ELEVATOR CO., LTD. (Otis Elevator Co., Incorporated, United States.) December 19th. (Complete.)

27,924. "Safety devices for electric railway systems." G. GIBBS. December 19th. (Complete.)

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1902.

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SYSTEMS OF ELECTRICAL DISTRIBUTION. E. A. Carolan. (General Electric Co.) 24,715. November 11th.

INSULATING MATERIAL FOR ELECTRIC CABLES. W. C. Johnson and S. Paterson. 24,756. November 11th.

JUNCTION BOXES FOR UNDERGROUND ELECTRIC CABLES. A. Sowden. 24,820. November 12th.

ELECTRICAL SYNCHRONISM AND PHASE INDICATORS. British Thomson-Houston Co., Ltd., and Clinker. 25,151.

ELECTRICAL INSTRUMENTS FOR SIGNALLING ON RAILWAYS. E. Tyer, F. T. Hollins, and F. W. Leake. 25,240. November 7th.

FREQUENCY AND SPEED INDICATORS. A. C. Heap. 25,578. November 21st.

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SYSTEMS OF ELECTRICAL DISTRIBUTION. E. A. Carolan. (General Electric Co.) 25,905. November 25th.

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ELECTRIC TRACK BRAKES. E. A. Carolan. (General Electric Co.) 26,038. November 26th.

ELECTRIC ARC LAMPS. E. A. Carolan. (General Electric Co.) 26,041. November 23rd.

ELECTRIC MOTORS. E. A. Carolan. (General Electric Co.) 26,042. November 26th.

1903.

SYSTEMS OF ALTERNATING CURRENT DISTRIBUTION FOR RAILWAYS. C. F. Scott. (Date applied for under Patents Act, 1901, September 18th, 1902, being date of application in United States.) 19,521. September 10th.

ELECTRO-MAGNETIC RELAY APPARATUS. Siemens Bros. & Co., Ltd. (Siemens and Halske Actien Gesellschaft.) 19,877. September 15th.

ELECTROMOTIVE FORCE REGULATORS. B. G. Lamme. (Date applied for under Patents Act, 1901, October 2nd, 1902, being date of application in United States.) 19,886. September 15th.

ELECTRIC SWITCHES. C. E. Hunter and W. H. Warren. 20,401. September 22nd.

ELECTRIC PLANT FOR THE SYNTHETICAL PRODUCTION OF NITRIC PRODUCTS BY MEANS OF DISCHARGES OF ELECTRICITY IN GASEOUS MIXTURES. J. von Kowalski and I. Moscicki. 20,497. September 23rd.

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